ANNUAL MAINTENANCE NUMBER

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*In this Issue*
MAINTENANCE PROBLEMS IN GLOBAL WARFARE

DEC. 1942

I.C.C.

# AVIATION

*The Oldest American Aeronautical Magazine*

McGraw-Hill Publishing Company, Inc.

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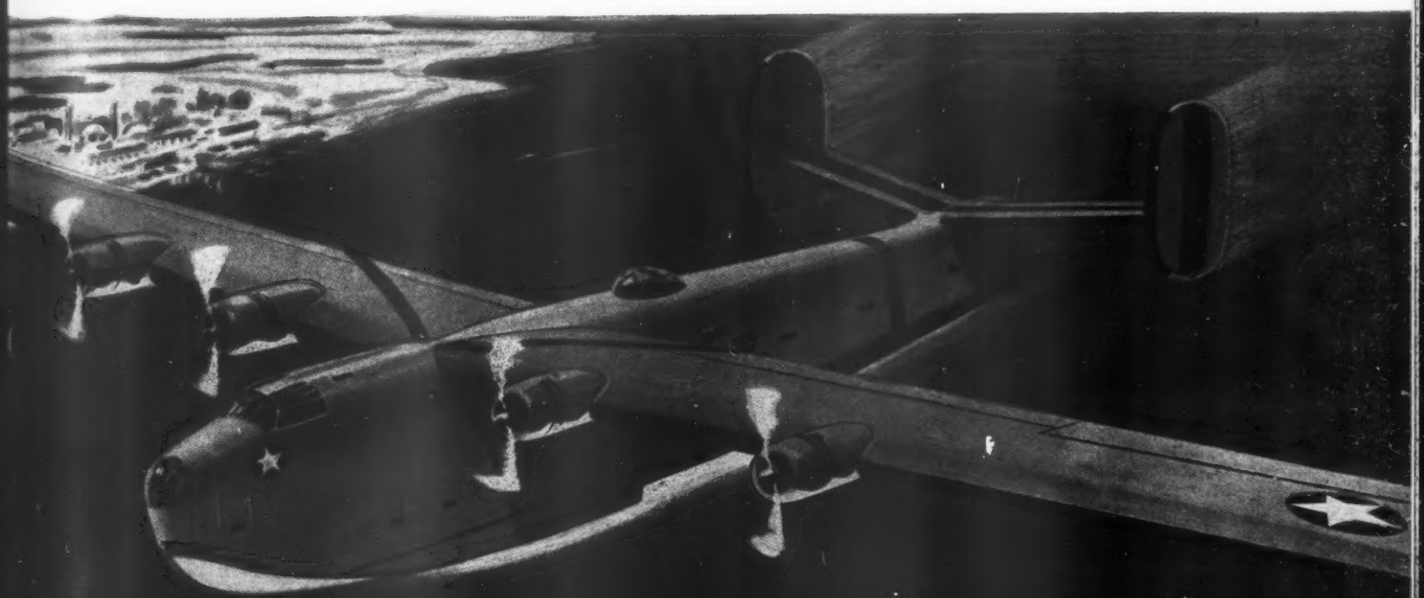

NAVY AIR TRANSPORTS
*fly the Seven Seas*

A fleet of Consolidated PB2Y Coronados is now helping the Naval Air Transport Service to deliver tons of supplies daily to Australia, Alaska, England and Africa.

Large fleets of long-range land planes and flying boats are also joining the Service, bearing such famous names as Consolidated, Curtiss-Wright and Douglas. All these, like the Coronados, are being powered by dependable Pratt & Whitney engines.

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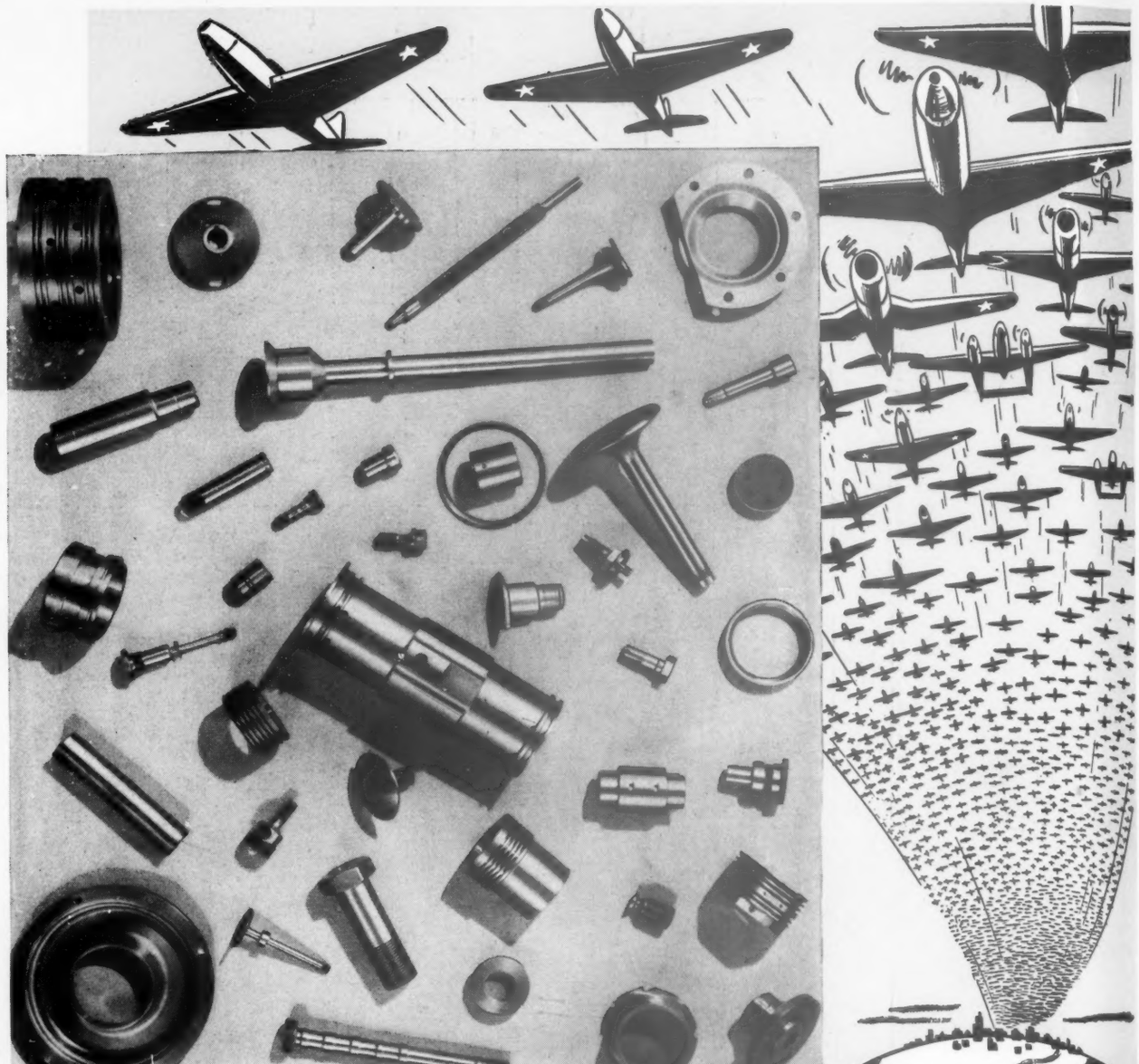

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This wartime impetus of more productive machines, skilled man-power and innovations in parts, engineering, and manufacturing will carry over into the peace era which will follow victory, advancing the entire field of internal combustion power.

THOMPSON PRODUCTS, INC., Cleveland, Ohio.

Thompson Products

# AVIATION

NUMBER 12 VOLUME 42

DECEMBER, 1942

Annual Maintenance Issue

REGULAR EDITION


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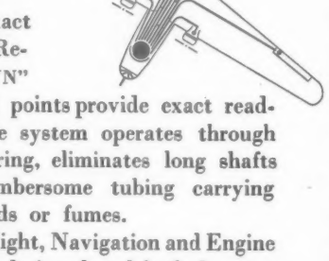
# Giving them Vital Facts by *Remote Indication*



SWIFT, intelligent action on the part of a combat plane's crew must be based on facts accurately determined and quickly conveyed. Obtaining and transmitting such information...from many vital points throughout the plane...is the important job entrusted to the "PIONEER AUTOSYN" System.

Incorporated in precision instruments in tail, flaps, landing gear, engines, fuel tanks and other parts of the plane, are "PIONEER" Transmitter "AUTOSYN" units like the one illustrated. These small, ingenious mechanisms transmit exact measurements. Receiving "AUTOSYN" units at desired points provide exact readings. The whole system operates through low voltage wiring, eliminates long shafts and heavy, cumbersome tubing carrying dangerous liquids or fumes.

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THE INVISIBLE CREW
Precision Equipment by Bendix
AVIATION CORPORATION

PIONEER INSTRUMENT DIVISION

# ★ ★ IN THIS ISSUE ★ ★

OUR DISTINCTIVE operating feature of AVIATION—the Maintenance Notebook—is presented in this issue in an improved and expanded form.

It covers the whole field of aircraft maintenance—military, airline, and civil. It is a graphic compendium of new ideas and advanced methods for busy maintenance executives and engineers.

Dealing with airplanes, engines, propellers, accessories, and equipment, it has been especially collated to impart the maximum of useful information in a minimum of time.

An up-to-the-minute installment of the Maintenance Notebook—in this new format—will appear in the Maintenance Section of every succeeding issue of AVIATION.

### Fighting-Front Maintenance

Throughout this warring world, maintenance of aircraft is a prime problem posing riddles which "square in ratio" to the distance from the factory. Yet staggering though these problems are, Yank maintenance men are meeting them with ingenuity in the face of adverse conditions of climate and despite the poor quality of native labor and equipment.

How they are doing it is pointedly revealed in two special features—Assembling and Testing P-40's in Burma, by Curtiss-Wright Test Pilot Byron A. Glover, who was "right on the ground in Rangoon," (page 96), and We Learned War Maintenance With the AVG, by Tye Lett, Jr., overseas representative of Allison, who played a leading field role with the Flying Tigers (page 104).

Paralleling these problems of the Orient are the heavy supply and maintenance burdens being shouldered by our aero servicemen in the many other fighting corners of the globe. On page 114, Donald S. Sprague, Douglas service expert, "pilots" us to Africa in his revealing feature, World Cargo Takes to the Air—shows us how the Air Transport Command is banishing the darkness from Dark Continent skies.

Meanwhile, the war must likewise be fought on the home front, and here we herald the significant contributions of the airlines. Comes the pertinent question: Is airline maintenance as good as it was before? "Yes", emphasizes Executive Vice-President Paul Richter, of TWA. "It's more than 'as good'—it's better than ever," he declares in his very forthright article, titled It's Like the Old Shoe—It Fits (page 102).

### Our Airline Awards

Fact is, airline maintenance is at such a spirited "high" that it was a most stringent task for the publishers to determine this year's winner of AVIATION'S annual awards for outstanding airline maintenance performance. But out of the strong field, two lines were flagged in—photo-finish fashion—to win the AVIATION plaques. Which two? See page 113, where the full story is told.

Next, the Aviation Manufacturing Section deals comprehensively with the complex design aspects of these paramount questions, with J. A. Knox and J. J. Boericke offering a wealth of practical approaches in Designing for Easy Maintenance (page 108). And the necessary liaison between the factory and front is recorded, in all its phases, by Frank H. Lyons. His excellent article, Bringing Field Experience Back to the Plant, is presented on page 124.

***Robert K. Kinzel** author of Developing Wider Cargo Markets (page 244), was struck by the great possibilities of air express when, during a South American trip, he saw mining machinery flown into the Andes and later, in Buenos Aires, ate lobsters which had been air-delivered from Chile. Today, as assistant to the express traffic manager of PAA, he still feels the same about air express—only more so. After whisking through Columbia College's four-year course in three, he traveled Europe and South America like a Marco Polo, and he's been to so many out-of-the-way places that he seldom needs to consult a map. Above all, he likes to think ahead to the coming peacetime "when," he says, "Airex will really start to grow."*

### BOX SCORE: 14 to 1

**Striking record of 141 enemy aircraft downed against a Yank loss of but 10—a solid 14 to 1—was chalked up by American combat flyers in October, according to Under Secretary of War Robert Patterson.**

**Guadalcanal:** Japs lost 310 planes to Yanks' 62—exactly 5 to 1—in first 78 days of occupation (Aug. 7 to Oct. 23). Highlight was destruction of an entire squadron of 20 "Zeros," with no American losses, on Oct. 23.

**India:** U. S. 10th Air Force shot down 39 Japs, plus 13 "probables," during month of November.

**Middle East:** Axis lost 45 warplanes against Yanks' 6 (7½ to 1) in pre-invasion period Oct. 1 to Nov. 5.

Further thorough-going design studies packed with "whys" and "hows" are Design and Installation Factors for Aircraft Hydraulic Accumulator Systems, by Edward M. Greer (page 150), and Design Considerations for Plywood Structures, by L. J. Marhoefer (page 146). The latter feature is the second in the author's special series.

### Standards Promoted

How the aviation industry is meantime pacing its tremendous growth since Pearl Harbor with consistent progress relating to standardization and interchangeability is told by Glen M. Aron in his analytical report Aircraft Standards Committee Program Keyed to War Needs (page 165).

Feature in the military department is How Our Navy Gears Pilots for War, by Lieut. (jg) Fred Tupper, Jr., (page 239). And in Civil Air Patrol Completes Year of Service (page 250) Maj. Earle L. Johnson tells the striking story of the CAP's great home-front contributions.

## Coming

IN JANUARY, an outstanding feature of AVIATION will describe an automatic engine synchronization system developed for multi-engine equipment. George W. Brady, chief engineer, and Marvin Meyer, project engineer, both of Curtiss-Wright Propeller Division, have collaborated on an engineering article which should prove a milestone in the development of aircraft propeller controls.

Another feature will summarize the aviation industry's magnificant war accomplishments. Metallizing for better maintenance, flight strips, and lofting at Northrop are but a few of the other subjects which will be covered by authorities in these fields for AVIATION's readers.

# "HELL ON WHEELS"

# THAT'S OUR DISH

When you're under fire, you can't limit a ship to the designer's ideal . . . a tactical mission or split-second combat may create conditions beyond the foreseen. An alarm for a sudden take-off—or a critical landing on whatever is below can mean "hell on wheels" . . . and Hayes Wheels and Expander Tube Brakes are facing this in line of duty. And taking it. Performance reports prove it.

Why? — because for Hayes equipment, "flying" starts way back in the factory. It goes through the design rooms, the test lab, the precision manufacture—all developed in step with aircraft advances through long years of civil and military use. (Every Expander Tube brake in use in the United States is a Hayes product—Hollerith designed and improved.)

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Illustration—Boeing B-17, "Flying Fortresses" with Hayes wheels and brakes.

**HAYES** AIRCRAFT WHEELS AND BRAKES . . .

HAYES INDUSTRIES, INC. Home Office: JACKSON, MICHIGAN, U. S. A.

# Electronics—Secret Weapon of War

## *Presager of a New Scientific and Industrial Era*

THE END of World War I left scientists with a new plaything. They did not know it at the time but they had their hands on a revolution. Within two years the world had radio broadcasting. Within ten years the whole art of motion pictures had been transformed as talking pictures replaced silent movies. Within twenty years television was born and people were seeing pictures in motion by radio.

The fulcrum of this revolution is the electron tube, a new tool of illimitable possibilities. One form of the electron tube is the familiar radio tube; the much publicized electric eye is another. There are many other forms, each having distinct capacities for saving time, saving energy, saving money, protecting life, limb and property.

The electron tube puts the electron to work—and the electron is the basic building-block of the universe.

Electronics is the new art, the new science of putting the electron to work. Radio and sound pictures and television are aspects of electronics; but there are many other facets of this revolution which have been brewing since the last war.

The electron tube has a typical American family tree. Edison made the basic discovery of the "Edison effect" some sixty years ago. This was followed by the invention of the "Fleming valve" and the "de Forest grid". Then Armstrong contributed his share, and hundreds of engineers in garret and cellar workshops and in the great university and industrial laboratories went to work on the tubes which employ electrons. The tube was a plaything before the last war but the world conflict brought it out of the toy stage and made it a practical, powerful tool.

Today the electron tube is guiding the destinies of the greatest armies and fleets ever engaged in the history of the world.

It is a part of the nerve center of the battleship, directing its course, finding its adversaries, broadcasting running accounts of air battles to its crews, directing gun fire and determining ocean depth.

In the air it is the means of locating and identifying enemy planes, piloting planes automatically, giving communication from plane to plane and to shore. It is even operating the controls of the plane.

In the maneuvering tank, in the officer's car, on the back of a foot soldier it transmits and receives vocal messages from every unit of the fighting forces.

Along our borders, and those of our Allies is an electronic screen which counts, follows and identifies enemy planes a hundred miles away through darkness and through fog.

In industrial plants there are electronic counters that enumerate passing articles faster than the eye can see; automatic sorters which discard defective, oversize, undersize, off-color articles; automatic cutters; devices which inspect the inside of things which the eye cannot see; controls which protect workers; controls of temperature; smoke eliminators; intruder alarms; automatic controls for whole batteries of machines.

In its October progress report on American industry, the War Production Board points out that the radio business is *five* times greater than a year ago. From 20 million dollars a month last fall, it has increased to well over 100 million dollars a month. Unfilled war orders are in excess of 4 billion dollars.

From such vast growth will emerge a new engineering of products which will immeasurably improve our peace-time living.

After the war broadcasting will be infinitely more satisfactory: radio receivers will perform with a new fidelity which will amaze us. Television reception will be as flawless as the motion picture. Present secret war developments will readily be convertible to peace-time devices that will improve our standard of living.

No longer will ships collide with other ships, with icebergs or the shore. No longer will trains collide and aircraft crash in flight.

Garage doors will open as we approach and automatically close themselves. Electric lights will automatically go on and off according to our wants and needs. Furnaces and boilers will be controlled and smokestacks will cease to belch wasteful smoke. Air will be made dust free and germ free. Food contamination will be checked, meat made tender.

Grade crossings will be made safe and auto traffic will be automatically controlled.

Medical science sees new wonders ahead. Already it is possible to see "whiskers" on germs, germs which heretofore had been but a blur when viewed through the strongest optical equipment available.

Today so much secret development is going on in the ultra-high-frequency field that little can be said of its great future. But, without divulging military secrets, it can be said that ply-wood is being dried electronically in minutes instead of hours. Ultra-high-frequency welding (not to be confused with flame welding controlled electronically) is being done dramatically and efficiently.

Ultra-high-frequency heating promises to revolutionize the baking industry—it may even heat our homes.

What is this miracle working tube that can see, hear, taste, feel and smell a thousand times more sensitively than was possible heretofore?

What is the electron? No one knows, not even the scientists who know how to employ it. Electrons cannot be seen or felt; but if 6¼ million million million electrons are pushed through a 100-watt electric lamp per second, it will light up to full brilliance. For electric current merely is a mass movement of electrons. Each electron carries its share of electricity, and since the electron has so little weight it can be moved easily and quickly. Therefore, electricity transported by electrons can be turned on or off with great ease and speed. The electron tube merely is a device that controls the flow of electricity. It is an amplifier of power which can be made to do wondrous things. The sound of a termite gnawing inside of a log can be amplified a million times . . . to a roar that can be heard over great distances.

Colors can be classified and matched to a degree not possible by any other means.

Chemical or vitamin consistency can be recognized by counting radio activity within the subject being analyzed.

There is no industry in which electronic circuits cannot be used to speed up production, to increase accuracy, to do heretofore impossible tasks of calibration and measuring.

The opportunities afforded the engineers who are developing this new "electronic age" are limitless.

* * * *

Today the electronic industry is 100% at war. It is meeting the exacting demands made upon it.

Never before was electronic equipment called upon to withstand temperatures ranging from 75 degrees below to 150 degrees above zero Fahrenheit. Never before did radios and transmitters have to withstand the shaking and abuse to which they are being subjected today.

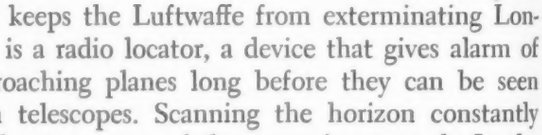
War demands have called for much redesign, much change of materials and a new conception of operating to tolerances never dreamed of in peacetime material. As a result, electronic parts and equipment makers are building better devices.

Universities and colleges are working at top speed to produce electronic engineers, for every radio operator in a plane, every radio man in the ground forces and on ships, every man operating radar equipment or electronic control devices in ordnance . . . and there are many thousands of them . . . must be a trained technician.

The wall of military censorship is high but it is no secret that one of Britain's best weapons that keeps the Luftwaffe from exterminating London is a radio locator, a device that gives alarm of approaching planes long before they can be seen with telescopes. Scanning the horizon constantly the locator warns of the enemy's approach. In the nose of a night fighter, the locator informs pilot and gunner when the enemy is within range. Neither is it a military secret that gunfire can be controlled by electronics, and that electronics is having a big share in training our new armies.

Necessity draws a veil over the most dramatic uses of electronics in warfare, but among those who know there is nothing secret about the fact that many of today's wartime applications will revolutionize our peace-time lives. Electronics will invade every industry with totally new devices and machines. The future of the electronics industry is limited only by man's imagination.

Such is electronics, and its destiny!



*President, McGraw-Hill Publishing Company, Inc.*

***This is the sixth of a series of editorials appearing monthly in all McGraw-Hill publications, reaching more than one and one-half million readers, and in daily newspapers in New York, Chicago and Washington, D. C. They are dedicated to the purpose of telling the part that each industry is playing in the war effort and of informing the public on the magnificent war-production accomplishments of America's industries.***

# The War Is Not Yet Won

THE CIVILIZED WORLD has been electrified by the brilliant beginning of the North African campaign, which has thrown the enemy into confusion and restored the long submerged self-confidence of our French Allies. Our strategists have demonstrated that they have learned well the complicated technique of blitzkrieg and our tacticians have added something new to its execution—the ability to make an occupation stick by careful diplomatic preparation and by making friends of the occupied populations.

The success of these operations are due to a large number of factors, among which are adequate land, sea and air forces deployed under conditions favored by timing, surprise, and diplomacy. But it must be remembered that the effective strength of our invading forces depended directly on the degree to which they were opposed. And whether we were to meet stiff or indifferent opposition depended largely on the diplomatic preparation for the attack.

Our experience so far in North Africa adds to the rapidly accumulating evidence supporting our appreciation of the realistic place of air power in the warfare of today. Like all other war machines, the airplane has its limitations, and, if we are to use it effectively, we must use it within the framework of these limitations. Air superiority still remains the essential ingredient of victory. Without it, defeat is inevitable. But it must be coordinated with all of the other ingredients if we are to have effective striking power.

AIR POWER consists of three fundamental elements—planes, men and bases. All three must be at the right place at the right time. The planes must be suited to the particular job in hand. Even more important than the plane is the man who flies it. It takes 20 years to "grow" a pilot. Some of our factories can build an airplane in not much more than 20 minutes. But there is nothing more futile than a pilot and airplane without gasoline or without a place from which to take off. Whether the base is the deck of a carrier, or the end of a convoy route to a jungle air field, it is absolutely necessary to air power.

This is *not* the time to shout loudly about victory. It is the time for hope but not over-optimism. There is much more to be done.

To quote the gifted phraseology of the British Prime Minister, it is only the "end of the beginning." Our forces are still a long way from Berlin and we must not underestimate the strength or craftiness of the enemy whom we are only now meeting.

Much depends upon the facility with which we are able to complete the occupation of that small but highly important remaining section of the North African coast which lies between our forces and complete control of the Mediterranean. When this is done and when the elimination of the Nazi Afrika Korps has been completed and our gains consolidated, we will be in a highly advantageous position. Hitler-controlled Europe will be almost entirely surrounded.

THE NEXT STEP will be the one in which air power will play the most important part. Whether or not it will be possible to force a decision by continuous and simultaneous air attack from our circularly disposed bases remains to be seen. But no matter how intensive this air action may be, it is probable that it will have to be accompanied by naval action and followed by land-occupation.

All of our present advantages may be rendered ineffective if the enemy is successful in interfering to any extent with our long lines of communication and that is probably what will be attempted. And our efforts will always be hampered while we have other important work to do in the Western Pacific.

Our still small offensive effort has gotten off to an excellent start. The outlines of our strategy are sound, and the tactical execution so far has been excellent. Now more than ever we of the home front must cast aside differences of opinion and petty jealousies and bend every effort to give our advancing armed forces all the support that they need.

Leslie E. Neville

# AMERICA AT WAR

## Second front opening gives several clues to the part American aircraft may be playing in future battles not only in Africa but on the continent.

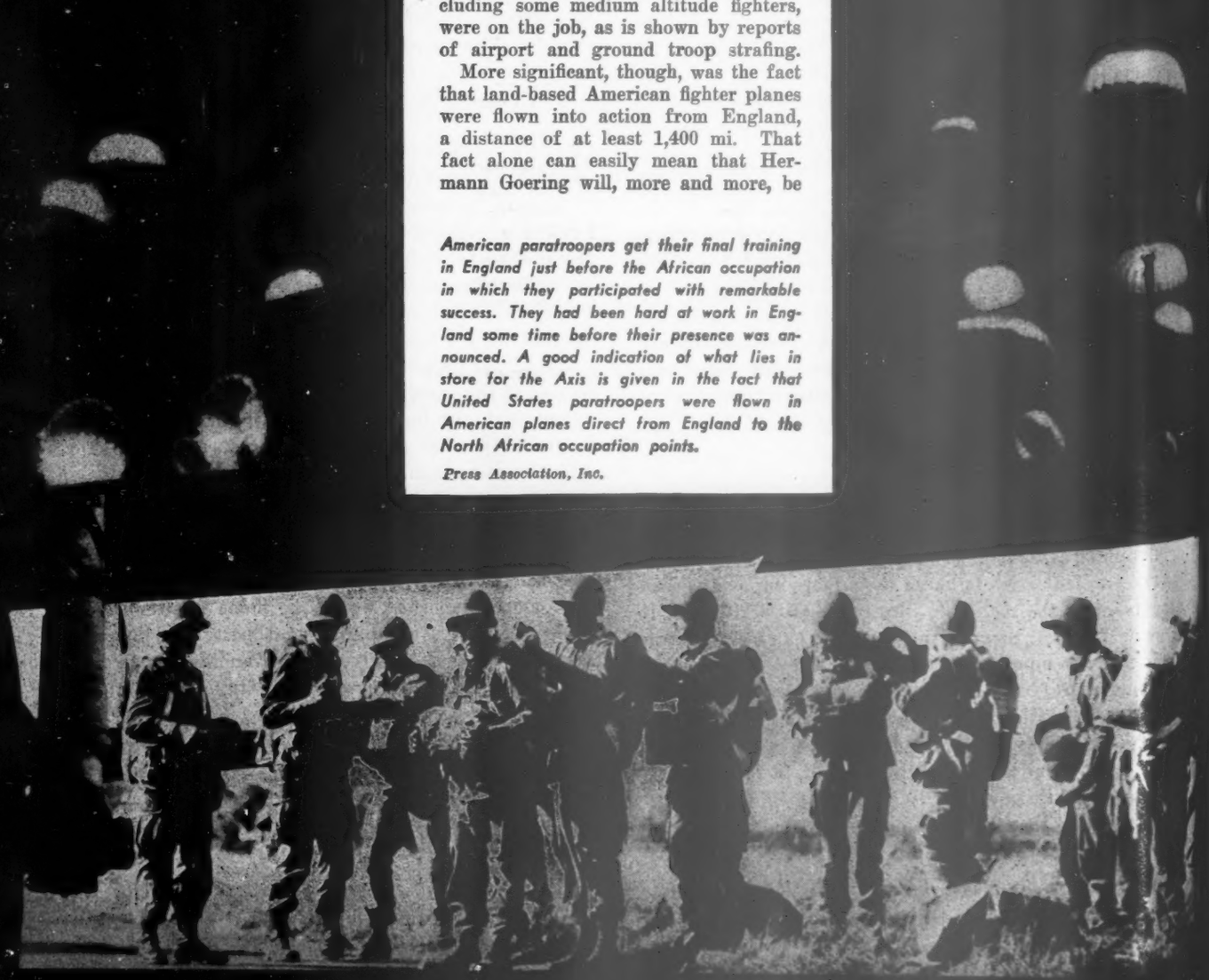
**A SECOND FRONT** has been opened; opened with perhaps as beautiful a bit of coordination as has ever been seen in military history.

The occupation of North Africa was more than coordination in time—getting all the units ashore on schedule under air protection—for it marked the perfect blending of all the elements of modern war: men, material and diplomacy.

That last element overshadowed even the part played by air power. In fact, pre-occupation diplomacy reduced to a minimum the need for fighter and bomber aircraft and at the same time provided adequate bases for the hard fighting which lies ahead. All fighting men—air, land and sea—owe a tremendous debt to one of the greatest international poker players, Secretary of State Cordell Hull.

Several clues to air power's coming role were revealed by the occupation, however. One straw in the wind was the obvious and the expected. Four-engine bombers participated under the direction of Brig. Gen. James Doolittle, who took over as co-pilot of one of them when the regular co-pilot was wounded in a brush with French fighter planes. American attack planes, perhaps including some medium altitude fighters, were on the job, as is shown by reports of airport and ground troop strafing.

More significant, though, was the fact that land-based American fighter planes were flown into action from England, a distance of at least 1,400 mi. That fact alone can easily mean that Hermann Goering will, more and more, be



*American paratroopers get their final training in England just before the African occupation in which they participated with remarkable success. They had been hard at work in England some time before their presence was announced. A good indication of what lies in store for the Axis is given in the fact that United States paratroopers were flown in American planes direct from England to the North African occupation points.*

*Press Association, Inc.*

figuratively running rapidly in several directions at once, getting no place fast. And no less important is the fact that paratroopers "hit the silk" after having been flown direct from bases in England.

This is heartening when we remember that Germany alone started the war with the only air force in the world capable of modern fighting. All the other belligerents had nucleus forces, but Germany alone seemed to have a clear concept of aviation reality. The rest had to learn and build at the same time. Whether the British were smart or lucky in having the basic design of a fighter, the *Spitfire,* which would take the lead in saving their country from invasion, and possibly the world from a period of Nazi domination, provides plenty of fire-side argument material.

But the world learned quickly from the Nazis. Russia, America, England, Japan—all have fighting aviation as good as Germany's. Therein lies a lesson warlike people should learn—but won't. The lesson is that if they aim a blitzkrieg at their neighbor, they should make sure to knock him cold, otherwise he will get up and blitz back. Aviation builds fast, and its technique is as fluid as the wind.

Since our last report on the globe-girdling battle of aircraft, the United Nations have obtained unquestioned air superiority on all fronts. That means Africa, Russia, the Southwest Pacific, and the English Channel. It is the realization of objectives which have been discussed here before. Months ago, the United States alone passed the entire Axis in the production of airplanes. That, plus the output of the British commonwealth, certainly seemed as if it should soon overwhelm the enemy. But, as was pointed out, the enemy was fighting from inside his stockade, so to speak, with all his factories and his military camps and his homes compact on his own soil. The Allies were scouting, stabbing and running around the edges, so it took a lot of airplanes to make a few in many different places.

But a woodpecker can fill any knothole with nuts if you give him time. The Russian and the Chinese Armies, and the American and British Navies have provided that time. Our flow of planes has filled up those many spots, and we are now coming out in force and hitting the enemy. He is hitting back, but the labored production of Japan and Germany can be no match in the long pull for the strength of the Allies with three-fourths of the world's man-hours and resources.

We are told on good authority that chances are the Axis will never again have control of the air for very long, over any considerable area, in this war. Hanson Baldwin, of the *New York Times,* one of the "typewriter strategists" who takes his machine right out on the line, says that our Navy has not yet learned how to coordinate its surface attack and its airplane attack. We have had some bad defeats in the Pacific lately, and one might assume Mr. Baldwin has told one of the reasons. If so, the enemy there may be said to have air superiority over us at times.

At home, in the production of airplanes, the country has had a temporary setback. Everyone is impressed with the work the aircraft manufacturers are doing—with their rapid development of mass production shortcuts; with their ingenious subassembly schemes; with their quick adaptation to materials substitutes; their flexible sideshows for handling design changes while the production line rolls right along. Mr. Roosevelt gave the impression that he marveled at the aircraft factories. In only two or three cases, since the war drive started, has the airplane industry been found at fault. Its enthusiasm, its sacrifice of its own competitive interests, all have won admiration.

But the job of taking inventory of the materials, particularly metals, and apportioning them to the various categories of war equipment appeared to be too much. Those who have tried to take over the little woman's job at breakfast time and get the coffee and the toast and the scrambled eggs all ready at the same time know the problem. The War Production Board's eggs were cold before the coffee boiled, and the toast burned up.

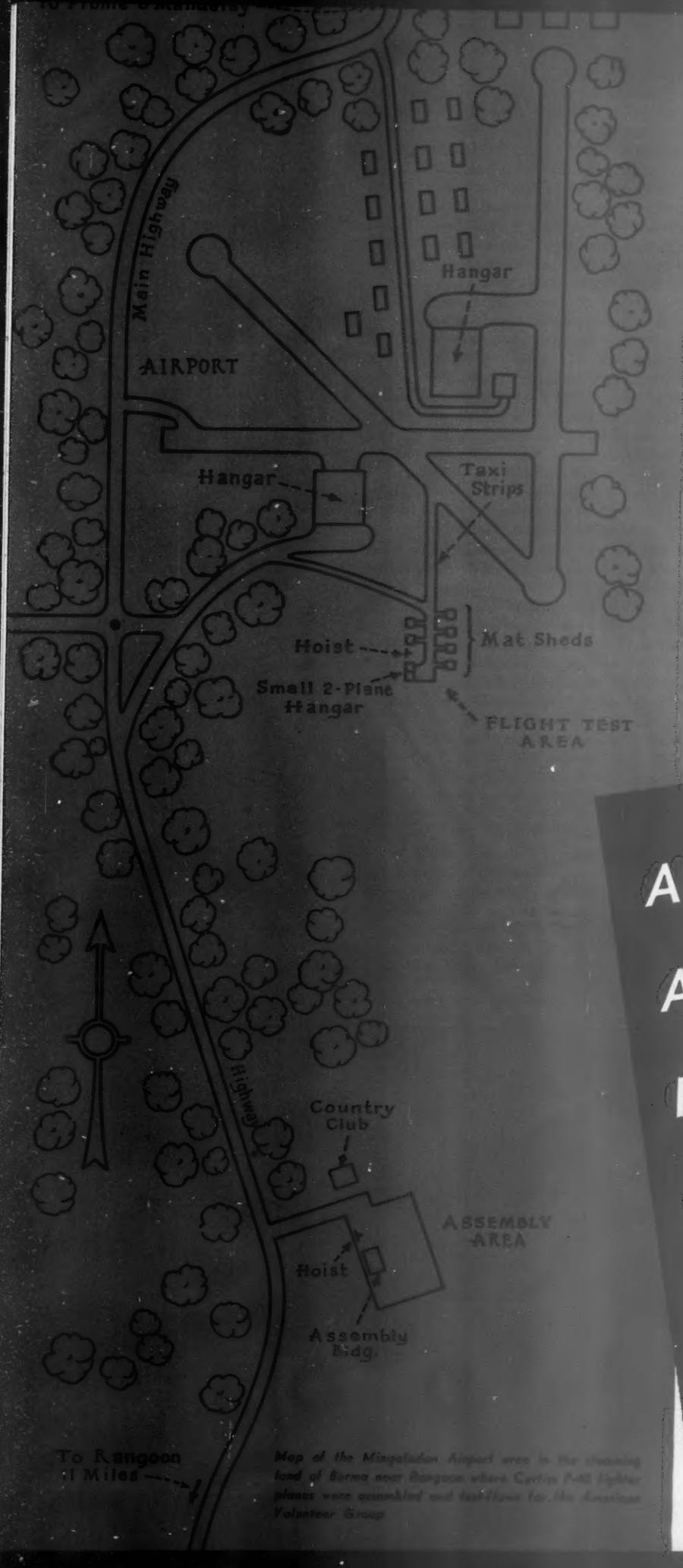
So, for four months, the output of airplanes has been running along on a nearly level basis. Recently it fell off. Production was better than it looked, however, because the ratio of smaller planes declined in relation to heavy bombers, which don't count up so fast. Actually, the tonnage and the dollar value of the planes did increase somewhat, but not enough.

The country is not meeting its plane schedule, but that is only part of the story. The military men have decided that the airplane program should undergo some changes. They want more armor, more and bigger guns, more ammunition, longer range, more power. The job is just as much harder as if they called for thousands of more airplanes.

The War Production Board is allocating the aluminum and the copper and the steel and the manpower to do the job. The Army and Navy will get what they want, but no exciting stories about vast numbers of planes can be expected for a while. That number yardstick for measuring air power is going out. That can be seen from reports of Boeing B-17's and Consolidated B-24's going out to fight off swarms of enemy planes, drop their bombs accurately and effectively, and get back

(*Turn to page* 323)

***Prominent in the news from the European theater of air war recently has been the new de Havilland "Mosquito" high-speed reconnaissance bomber which first made headlines in the raid on Gestapo headquarters in Oslo, Norway, a round trip of approximately 1,000 mi. Of all-wood construction, the "Mosquito" has a span of 54 ft. 2 in., over-all length of 40 ft. 9½ in., and height of 15 ft. 3 in., and is reported to mount four 20-mm. cannon and four 0.303 machine guns. Top speed has not been revealed, but the two Rolls-Royce engines spinning de Havilland three-blade hydromatic propellers are said to give the planes speed which has enabled them to outrun Focke-Wulf 190's at low altitudes.***




*Map of the Mingaladon Airport area in the steaming land of Burma near Rangoon where Curtiss P-40 fighter planes were assembled and test-flown for the American Volunteer Group*

**Assembling and testing fighter planes for action thousands of miles from the factory under staggering climatic conditions and with native labor and equipment is a job that calls for ingenuity and imagination. The remarkable performance of the AVG against the Japs in Burma was fully matched by men who assembled the planes for the Group to fly.**

# ASSEMBLING And TESTING P-40's In BURMA

By BYRON A. GLOVER
*Test Pilot, Curtiss-Wright Corporation*

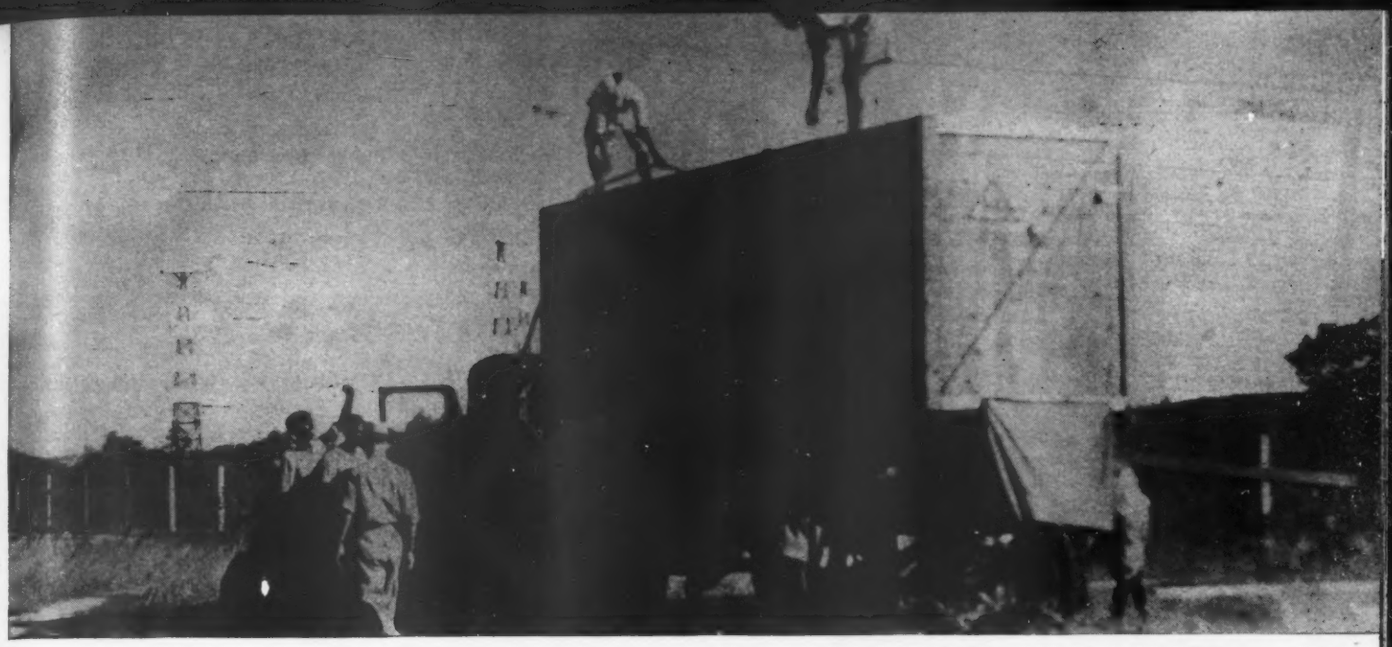


*FIG. 1. Native Burmese laborers preparing to unload a fuselage crate from one of the two trailers especially built to haul the plane sections from the dock to the assembly area.*

IN APRIL, 1941, I was engaged as test pilot by an American company which had contracted to assemble, flight test, and deliver to the Chinese government 100 Curtiss P-40 (*Tomahawk*) fighter planes. These planes were later used by the American Volunteer Group to defend the Burma Road, and assembly and delivery was performed in Rangoon, Burma.

I left Los Angeles in May for Hong Kong by Pan American Clipper. Connections were made after a four-day layover with China National Airways. The flight from Hong Kong to Chungking was made without event although the first part of the trip was made over territory held and patrolled by the Japanese, and takeoffs were made only at night or in "unflyable" weather.

The Chungking airport is unique. It consists of a long, narrow landing strip in the center of an island in the Yangtze River. For certain periods of the year it is under water when the river is at flood tide, and for this reason the runway is paved with huge stone slabs about 3 ft. by 4 ft. in size and about 1 ft. thick. On the way from Chungking to Lashio, Burma, I noticed several twin-engine Beechcraft used for training pilots by the Chinese government at the Kunming airport.

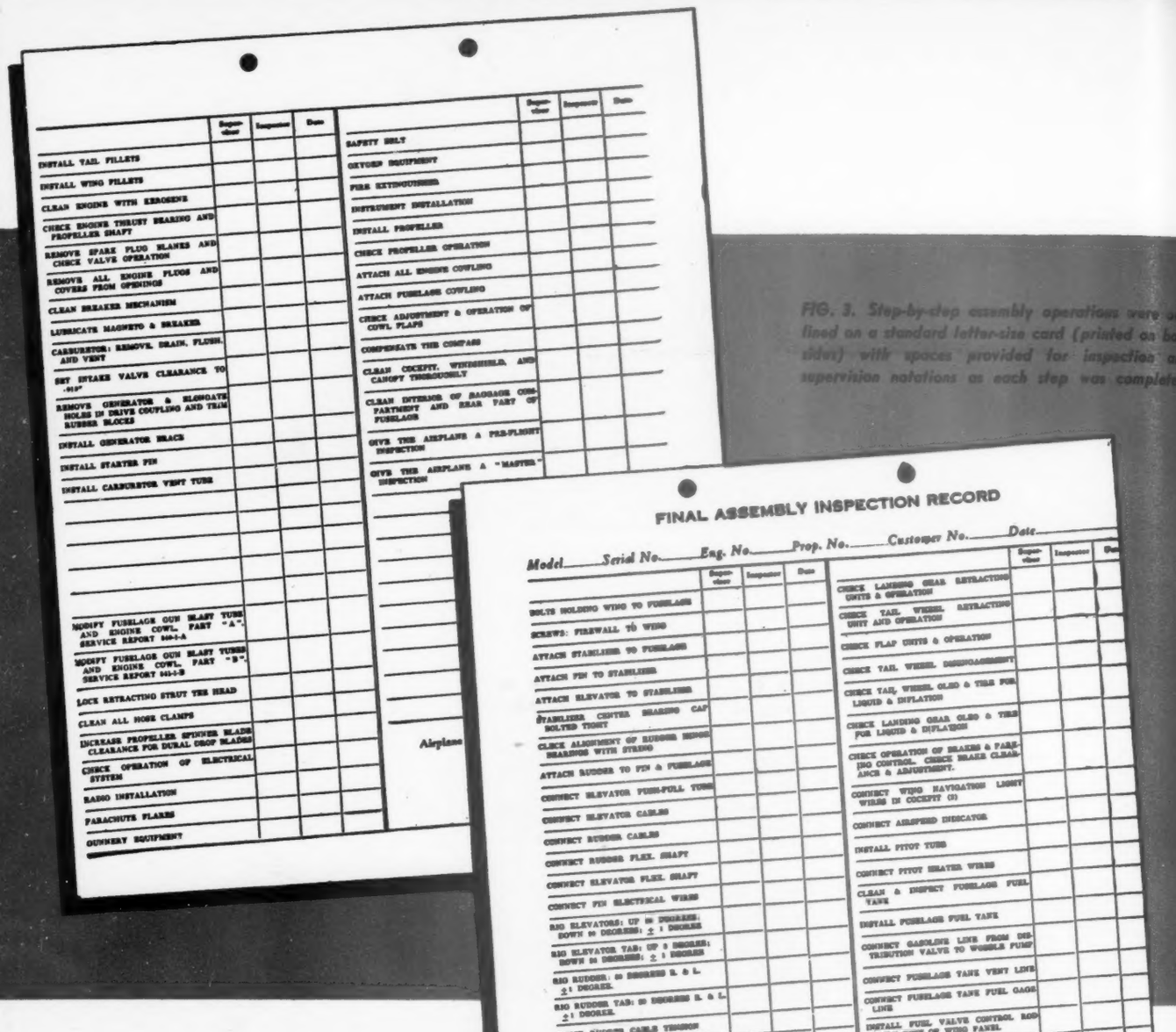
The last leg of the flight was from Lashio to Rangoon. After flying in cool air at 13,000 ft., the tropical heat of 110 to 115 deg. in Rangoon was staggering. I was told that considerable relief from the heat would be afforded when "the rains came"—and this proved to be so. The thermometer dropped way down to 95 deg. and remained there until the end of the rainy season in October.

Our Rangoon office was managed at this time by Mr. Dan F. Gourlie.

*FIG. 2. A group of Chinese supervisors in charge of assembly operations. These men did a superhuman job and directed operations with unusual skill and intelligence.*

His staff consisted of about a dozen people whose homes were in Rangoon. From Mr. Gourlie I learned that the company had already secured a small piece of land near the Rangoon airport and had let a contract for the construction of a small assembly building. The contract had been given to Clark & Gregg, a local contractor. It had originally been planned to use the roof trusses of the assembly building for hoisting the fuselages of the airplanes during assembly. Upon checking over the plans for the design of the assembly building I discovered that the roof trusses as originally planned were not strong enough to carry the weight of the P-40 fuselage. Mr. Gourlie and I then had a conference with the contractor, who upon learning of our requirements agreed to replace two of the wooden truss members of the roof under each end of the building with two steel truss members that would be capable of carrying a load of over 3 tons each. Construction of the side walls of the assembly building had just been started at this time and it was estimated that it would require approximately two months before the building would be completed.

Since the P-40's were expected to arrive before the building would be completed it was decided at this time to



| | Supervisor | Inspector | Date |
|---|---|---|---|
| INSTALL TAIL FILLETS | | | |
| INSTALL WING FILLETS | | | |
| CLEAN ENGINE WITH KEROSENE | | | |
| CHECK ENGINE THRUST BEARING AND PROPELLER SHAFT | | | |
| REMOVE SPARK PLUG BLANKS AND CHECK VALVE OPERATION | | | |
| REMOVE ALL ENGINE PLUGS AND COVERS FROM OPENINGS | | | |
| CLEAN BREAKER MECHANISM | | | |
| LUBRICATE MAGNETO & BREAKER | | | |
| CARBURETOR: REMOVE, DRAIN, FLUSH, AND VENT | | | |
| SET INTAKE VALVE CLEARANCE TO .012" | | | |
| REMOVE GENERATOR & ELONGATE HOLES IN DRIVE COUPLING AND TRIM RUBBER BLOCKS | | | |
| INSTALL GENERATOR BRACE | | | |
| INSTALL STARTER PIN | | | |
| INSTALL CARBURETOR VENT TUBE | | | |
| MODIFY FUSELAGE GUN BLAST TUBE AND ENGINE COWL, PART "A", SERVICE REPORT 849-F-A | | | |
| MODIFY FUSELAGE GUN BLAST TUBE AND ENGINE COWL, PART "B", SERVICE REPORT 849-F-B | | | |
| LOCK RETRACTING STRUT TEE HEAD | | | |
| CLEAN ALL HOSE CLAMPS | | | |
| INCREASE PROPELLER SPINNER BLADE CLEARANCE FOR DURAL DROP BLADES | | | |
| CHECK OPERATION OF ELECTRICAL SYSTEM | | | |
| RADIO INSTALLATION | | | |
| PARACHUTE FLARES | | | |
| GUNNERY EQUIPMENT | | | |

| | Supervisor | Inspector | Date |
|---|---|---|---|
| SAFETY BELT | | | |
| OXYGEN EQUIPMENT | | | |
| FIRE EXTINGUISHERS | | | |
| INSTRUMENT INSTALLATION | | | |
| INSTALL PROPELLER | | | |
| CHECK PROPELLER OPERATION | | | |
| ATTACH ALL ENGINE COWLING | | | |
| ATTACH FUSELAGE COWLING | | | |
| CHECK ADJUSTMENT & OPERATION OF COWL FLAPS | | | |
| COMPENSATE THE COMPASS | | | |
| CLEAN COCKPIT, WINDSHIELD, AND CANOPY THOROUGHLY | | | |
| CLEAN INTERIOR OF BAGGAGE COMPARTMENT AND REAR PART OF FUSELAGE | | | |
| GIVE THE AIRPLANE A PRE-FLIGHT INSPECTION | | | |
| GIVE THE AIRPLANE A "MASTER" INSPECTION | | | |

Airplane

*FIG. 3. Step-by-step assembly operations were outlined on a standard letter-size card (printed on both sides) with spaces provided for inspection and supervision notations as each step was completed.*

**FINAL ASSEMBLY INSPECTION RECORD**

Model..... Serial No..... Eng. No..... Prop. No..... Customer No..... Date.....

| | Supervisor | Inspector | Date |
|---|---|---|---|
| BOLTS HOLDING WING TO FUSELAGE | | | |
| SCREWS: FIREWALL TO WING | | | |
| ATTACH STABILIZER TO FUSELAGE | | | |
| ATTACH PIN TO STABILIZER | | | |
| ATTACH ELEVATOR TO STABILIZER | | | |
| STABILIZER CENTER BEARING CAP BOLTED TIGHT | | | |
| CHECK ALIGNMENT OF RUDDER HINGE BEARINGS WITH STRING | | | |
| ATTACH RUDDER TO FIN & FUSELAGE | | | |
| CONNECT ELEVATOR PUSH-PULL TUBE | | | |
| CONNECT ELEVATOR CABLES | | | |
| CONNECT RUDDER CABLES | | | |
| CONNECT RUDDER FLEX. SHAFT | | | |
| CONNECT ELEVATOR FLEX. SHAFT | | | |
| CONNECT FIN ELECTRICAL WIRES | | | |
| RIG ELEVATORS: UP 28 DEGREES; DOWN 20 DEGREES; ± 1 DEGREE | | | |
| RIG ELEVATOR TAB: UP 8 DEGREES; DOWN 20 DEGREES; ± 1 DEGREE | | | |
| RIG RUDDER: 30 DEGREES R. & L. ± 1 DEGREE. | | | |
| RIG RUDDER TAB: 30 DEGREES R. & L. ± 1 DEGREE. | | | |
| CHECK RUDDER CABLE TENSION | | | |
| CHECK ELEVATOR CABLE TENSION | | | |
| CONNECT HYDRO LINES TO HAND PUMP | | | |
| CONNECT HYDRO LINES TO SELECTOR VALVE | | | |
| CONNECT HYDRO LINES FROM BRAKE PEDALS TO BRAKES | | | |
| CONNECT HYDRO LINES FROM SELECTOR VALVE TO WHEELS | | | |
| CONNECT HYDRO LINES FROM SELECTOR VALVE TO FLAPS | | | |
| FILL HYDRAULIC SYSTEM AND BLEED LINES | | | |
| FILL AND BLEED HYDRO BRAKE SYSTEM | | | |
| INSTALL BATTERY. | | | |

| | Supervisor | Inspector | Date |
|---|---|---|---|
| CHECK LANDING GEAR RETRACTION UNITS & OPERATION | | | |
| CHECK TAIL WHEEL RETRACTING UNIT AND OPERATION | | | |
| CHECK FLAP UNITS & OPERATION | | | |
| CHECK TAIL WHEEL DISENGAGEMENT | | | |
| CHECK TAIL WHEEL OLEO & TIRE FOR LIQUID & INFLATION | | | |
| CHECK LANDING GEAR OLEO & TIRE FOR LIQUID & INFLATION | | | |
| CHECK OPERATION OF BRAKES & PARKING CONTROL. CHECK BRAKE CLEARANCE & ADJUSTMENT. | | | |
| CONNECT WING NAVIGATION LIGHT WIRES IN COCKPIT (3) | | | |
| CONNECT AIRSPEED INDICATOR | | | |
| INSTALL PITOT TUBE | | | |
| CONNECT PITOT HEATER WIRES | | | |
| CLEAN & INSPECT FUSELAGE FUEL TANK | | | |
| INSTALL FUSELAGE FUEL TANK | | | |
| CONNECT GASOLINE LINE FROM DISTRIBUTION VALVE TO WOBBLE PUMP | | | |
| CONNECT FUSELAGE TANK VENT LINE | | | |
| CONNECT FUSELAGE TANK FUEL GAGE LINE | | | |
| INSTALL FUEL VALVE CONTROL ROD THRU NOSE OF WING PANEL | | | |
| MAKE ALL CONNECTIONS TO GASOLINE SELECTOR VALVE IN FRONT OF FIRE WALL | | | |
| INSTALL ARMOR PLATE, STA. 8 | | | |
| CONNECT AILERON CABLES. | | | |
| CHECK AILERON CABLE TENSION | | | |
| CHECK AILERON RIGGING: DROOP 5/16 TO 1/4 WITH STICK IN NEUTRAL; MOVEMENT UP 15-5/4 ± 1 DEGREE; DOWN 10 DEGREES ± ZERO | | | |
| CHECK FLAP RIGGING: DOWN 40 DEGREES; BOTH EQUAL | | | |
| INSTALL WING TIPS & CONNECT NAVIGATION LIGHT WIRES | | | |

rush construction of a number of small derricks that could be used both in assembly and in working on the landing gear and in checking landing gear operation after assembly. I designed a simple hoist consisting of an inverted U-frame built out of steel I-beams used in conjunction with a 3½-ton chain hoist fastened in the center at the top (Fig. 6) These frames were tilted slightly forward so that they would clear the leading edge of the wing, and they were braced on either side by two steel cables which were anchored to the horizontal steel I-beams forming the feet of the frame. This type of construction was simple and cheap to build and could be salvaged almost 100 percent after the assembly operations were completed. These hoists were located in the assembly area just outside of the assembly building, and others were located at the airport proper, where the flight test operations were to be carried on. Another problem to be solved was to find some way to get the large and heavy airplane crates from the docks out to the assembly building 11 mi. north of Rangoon. The box containing the fuselage and motor was approximately 35 ft. long, 10 ft. high, and 6 ft. wide and weighed just under 8,000 lb. The box containing the wing was approximately 40 ft. long, 10 ft. high, 5 ft. wide, and weighed approximately 8,300 lb. Obviously, none of our standard trucks then available could handle the job of taking these crates out to the assembly building. There were in Rangoon at that time scores of truck assembly plants and truck body manufacturers who were busily engaged in assembling trucks that were to be used to transport supplies over the Burma Road to China. We needed at least two large truck trailers, and knowing the size they would have to be, we took our problem to one of the larger truck body manufacturers who worked up a satisfactory design and built them in a month. (Fig. 1)

They served the purpose very well, and were easily disposed of to a local concern after our assembly operations had been completed.

## Labor

Then came the problem of obtaining labor. Our company had previously been operating an aircraft assembly plant in southwestern China so we arranged to borrow a skilled American aircraft foreman by the name of Andrew Sargeant and a group of 175 trained Chinese aircraft workers. (Fig. 2) These men had had previous experience on other types of airplanes, but had never seen the P-40 type of airplane before. To assist them in the operation I prepared and had printed a quantity of standard letter-size cards on which were printed each individual step in the assembly operation as it was to be carried out. (Fig. 3) By the side of each item was a place for the signature or stamp of the crew supervisor who performed the job and for the inspector who followed him. There were places on the top of the card for engine and airplane numbers and other pertinent information. As each airplane was uncrated, a card was filled out and attached to the airplane, remaining with it until the airplane was finally delivered to the airport for flight test. This system worked out unusually well in practice, and was of great assistance both to the workers themselves and to the inspectors who put their final O. K. on the airplane.

## Assembly Procedure

When these boxes were loaded on our trailers at the docks and transported to the assembly area, all further unloading and handling operations had to be carried out with manual labor. For work of this nature we employed a large number of Indian coolies. (Fig. 4) When the boxes arrived at the assembly area they were skidded off the trailers onto the ground, and scores of coolies held ropes tied to the top of the boxes to prevent them from toppling over as they were unloaded. (Fig. 5) When an airplane was needed for assembly, the top and sides were removed from the crate containing the fuselage. The bottom or floor of the crate was left on, as it was attached to the fuselage with an angle iron framework. Sections of 4-in. pipe were used as rollers and the fuselage was then rolled and skidded into place under one of the hoisting frames. (Fig. 6) The fuselage sling was then attached to the rear of the motor mount and the airplane hoisted into the air. With the fuselage a few inches off the ground, the bolts attaching it to the bottom section of the crate were removed and the bottom section

*FIG. 4. A group of Indian coolies employed for thee arduous task of unloading the airplane crates at the assembly area.*

*FIG. 5. The crates were unloaded by means of skids from the trailers. The strong-armed coolies eased the crates down the skids and kept them from toppling by means of ropes.*

*FIG. 6. The tops and sides of the fuselage crates were knocked off, and the fuselage, still mounted to the bottom of the crate, was rolled up to the hoist.*

of the crate was then taken away. The hoisting of the fuselage was then continued until it was high enough in the air to permit bringing the wing underneath it. (Fig. 7.)

The wing case contained the wing proper in one piece, all of the tail surfaces, fairings, and the propeller. At this time the wing case was disassembled and the tail surfaces and the propeller were removed. Then the wing was carefully lowered to a horizontal position by hand using as many coolies as could conveniently get a grip on the wing without getting in each other's way. The wing was then carried by hand over to the place where the fuselage was hoisted and waiting for the wing. As the wing panel alone weighed over 2,500 lb., this was no mean task, and it was always surprising to me to see how much weight these coolies could carry, both individually and as a group. The wing was brought into position beneath the fuselage and supported on two wooden horses which were heavily padded where they came into contact with the lower surface of the wing panel. The fuselage was then lowered onto the wing and the bolts holding the wing to the fuselage were put in place and tightened. The entire hydraulic system was then connected up and put into operation. The airplane was then hoisted again into the air and the horses supporting the wing were removed. At this time the hydraulic system was tested for leaks, and the landing gear was lowered and checked for proper operation. If everything was in proper working order, the airplane was then lowered to the ground and rolled away on its own wheels to make room for another airplane under the hoist.

Considerable assembly operations were carried on with these outside hoists before the assembly building was completed. When this was completed there were facilities for hoisting and assembling four airplanes: Two inside the assembly building, one outside the assembly building, and one at the airport. The assembly building (Fig. 8) had a lean-to on the west side which was divided into several rooms including the drafting room, a battery room, a stockroom, an instrument room, a first aid room or hospital, and the office.

*FIG. 7. The simple but effective hoist was designed by the author and was employed to keep the plane off the ground until the wing was mounted and the plane sufficiently assembled to be rolled away on its own landing gear.*

## Assembly Time Improved

There was sufficient ground space to store ten airplanes in their crates and also space for the assembly crew to work on five partly assembled airplanes. As soon as the airplanes were rolled away on their own wheels, a supervisor and his crew were assigned to it to continue assembly operations. It was customary, after operations got into full swing, to have complete crews working on as many as six or seven airplanes at one time. There was also another crew assigned to the airport for the purpose of getting the airplanes ready for flight, warming up the engines, and making minor adjustments after the airplane had been flight tested. In the beginning, the first airplane required approximately three weeks from the time assembly was started until the airplane was ready for flight test. The time required for assembly steadily decreased as the crew gained experience. After approximately one-half of the airplanes had been assembled, the assembly crew had become so skilled in their work that they were turning out airplanes at the rate of two to three per day. This is quite a compliment to the Chinese crew, and shows that they are much better workmen and mechanics than we have been accustomed in the past to think. About 15 members of the assembly crews were supervisors and they were the only ones who spoke English. These supervisors studied the

*FIG. 8. The completed assembly building at the airport. Steel trusses were substituted for wood because the latter could not support the weight of the airplane. This delay in construction of the building was overcome by the outside assembly hoists—which were maintained after completion of the building giving a total of four assembly fixtures.*

*FIG. 9. These mat sheds were built to protect the forward part of the planes from the blistering sun which caused the metal to become so hot that it could not be touched.*

Curtiss-Wright assembly handbook constantly and were instructed and guided in their work by Mr. Sargeant, who had had wide experience in all types of airplane construction and assembly. The workmen themselves were intelligent, but they did require constant supervision. Although the supervisors spoke English, their vocabulary was not very large, and it was often difficult to make them understand just exactly what was desired. However, when they once understood what we wanted, the work was carried out quickly and efficiently. During the latter part of the assembly period we had available the services of a Mr. Coo, of Allison Motors, who spoke English and Chinese fluently, and was of great assistance to us, both as an instructor to the Chinese crew and as an interpreter whenever we got in a tight spot.

## Aided by Aircraft Design

The disassembly and crating of the airplanes at the Curtiss-Wright factory was designed with the idea of making the airplanes as easy to reassemble in the field as possible. The fuselage assembly contained the motor, the oil tank, the Prestone tank, the fuselage fuel tank, the battery, the oil tank, and the Prestone and oil radiators, all connected up so that the motor could be run as soon as the propeller was installed. The entire wing was in one piece with the exception of the wing tips and had only to be bolted to the bottom of the fuselage with approximately 44 bolts. Connections to be made between the wing and the fuselage after they had been joined together were fuel lines, hydraulic lines and electrical connections. The landing gear was completely installed in the wing panel at the factory and was ready for operation as soon as the hydraulic lines were connected. As soon as the wing was installed on the fuselage and the hydraulic system was put into operation, the airplane could be rolled around on its own wheels to a location where assembly could be continued. At this time the control surfaces, the propeller, and the fairings were installed. The only rigging necessary on the airplane was to see that the control surfaces moved through their proper range and that all controls were free. The planning of the whole of the above was such as to provide a maximum of ease and simplicity for assembling the airplanes in the field. Out of the 100 airplanes shipped, only one was damaged in shipment. The wing case on this airplane was dropped in the water in New York Harbor while loading it and when it arrived in Rangoon the wing was so badly corroded that I did not think it safe to assemble and fly this airplane. This was extremely fortunate in one way, since it gave us a source of extra instruments and other necessary spare parts. Most of the trouble experienced on the airplanes was due to the instruments going bad in transit, probably due to jarring and exposure to weather on board ship. Some of the instruments could be repaired, but some of them were beyond local repair. There was a shortage of all kinds of small hand tools, wrenches, vises and special engine tools. We experienced a great deal of spark plug trouble, probably due to the high humidity during which flight operations were carried on, and also due to the fact that we did not have the proper tools for overhauling and setting the gaps of the spark plugs. There was only one case of complete failure of a magneto.

## Flight Testing

When the airplanes were completed, the engines were given a preliminary run up at the assembly plant and then they were either towed or taxied down the main highway for a distance of 1 mi. to the airport proper, across the airport to one corner where our flight test area was located. The flight test area was located off the main runways on the south edge of the airport. The ground was very soft off the runways, and we found it necessary to construct taxi strips of crushed stone from the flight test area out to the runways. All of the flight test operations were carried on during the rainy season. Although it does not rain all of the time during the rainy season, it does rain a large percentage of the time. There are rainy periods of from three days to one week, followed by clear weather for two or three days. During the rainy weather there are three or four heavy rain squalls each day which last for from one to four hours. In between these rain squalls there are periods of from one to two hours of clear weather during which flight operations can be carried on. When it is not raining the sun is shining brilliantly and the air is both very hot and very humid. The high humidity caused excessive condensation in the fuel tanks overnight and it was found necessary to drain the water from all fuel tanks and to drain the fuel strainers immediately prior to each flight. The sun shining on the unpro-

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*FIG. 10. One-half of the airport hangar. This building was used whenever an airplane required long or extensive repairs.*

*FIG. 11. Line of completed P-40 "Tomahawk" airplanes awaiting delivery to American Volunteer Group pilots.*

# IT'S LIKE THE OLD SHOE— IT FITS

**A leading executive tells why airline maintenance is as good and better now than ever before.**

By **PAUL E. RICHTER,** *Executive Vice-President, Transcontinental & Western Air, Inc.*

HERE IS HOW THE nation's airlines are able to carry out numerous war-effort assignments, yet keep maintenance and safety standards of their commercial fleets even higher than before Pearl Harbor:

Master craftsmanship, plus familiarity with tried and true equipment—the DC-3 transport!

The "how it's done" question is one most frequently asked airline operators. In my opinion, the answer is the simple one stated above. This type of transport, which has been standard on airlines for a number of years, is like the old shoe—it fits.

The auto mechanic who spent six years working on model-T cars knew just where to look for every squeak or wheeze. Through years spent on DC-3 equipment, our maintenance crews, likewise, have become familiar with every nut, bolt and screw on the transports, which have proved their sturdiness and reliability in virtually every part of the world.

All the "bugs" were removed long ago. The maintenance specialist, through these years of experience, knows exactly what adjustment is necessary. Jobs are better organized, so there is no lost motion. Through increasingly efficient procedure, the crews know just when the next plane will be in the hangar and just what operation is necessary to keep it at peak performance.

We realize it is our patriotic duty to carry every ounce possible on equipment available and operate that equipment more hours daily and at the same time continually raise our high standard of maintenance and safety.

To operate our planes longer hours, more rapid turn-around of our aircraft is necessary and our maintenance dispatching procedures have been of great benefit in this regard. In order to keep an even flow of maintenance and overhaul operations coming into our bases, the planes are scheduled in such a manner that a large number of major changes and service operations will not fall due at the same time.

In addition, TWA is perfecting a system whereby mechanical personnel at terminal stations are trained as specialists. To a certain extent, this system increases the man-hours, but it reduces the time a plane is tied up for maintenance.

During the month of September, 1941, maintenance and overhaul work required a total of 97,737 man-hours while in the same month this year the man-hours totaled 83,042, although we were operating considerably less equipment, proving that safety standards have not been sacrificed.

The maintenance personnel at our principal stations, New York, Pittsburgh, Chicago, Kansas City, San Francisco and Los Angeles, totaled 986 in November of 1941. In November of this year the total had jumped to 1,335 at these stations. These specialists were engaged exclusively in the servicing of commercial planes at all stations except Kansas City. At the latter, the crews spend some time servicing government equipment. Trained service crews are maintained at all other stations along TWA's coast-to-coast system.

Although our commercial fleet has been reduced 43 percent to meet the needs of the military, our higher utilization of equipment has made it possible for us to hold the decrease in commercial plane mileage to 23 percent. During October, this year, for example, we flew 1,347,437 revenue plane miles in our commercial operations compared to 1,745,239 in October of 1941 when we operated 43 aircraft units as against 25 this year.

*Holder of transport pilot's license No. 501, with more than 3,500 logged flying hours, Paul E. Richter, executive vice-president of TWA, knows whereof he speaks when it comes to airline operations.*

Proof that maintenance standards of TWA are higher than ever before can be found in a comparison of slight flight delays owing to minor mechanical adjustments. In last winter's operations, mechanical delays averaged one every 11,000 mi. flown, while in October of this year the average was one delay in every 16,000 mi.—a substantial in-

dication of increased maintenance efficiency.

Our DC-3 fleet was scheduled to operate 11:14 hours per plane daily in October, 1942, equalling the high efficiency figure attained in the operation of our former fleet of five Boeing *Stratoliners.* The 33-passenger *Stratoliners,* which TWA had in domestic service, have been operating for the Army in foreign courier service since last March.

Every non essential item has been removed from the planes so they can carry the greatest possible loads of vital materials and passengers. In October, this year, for example, TWA utilized 92 percent of space available in its fleet. This includes passengers, express and mail. Our express pound miles for nine months of 1942 show an increase of 151 percent over the corresponding period of 1941.

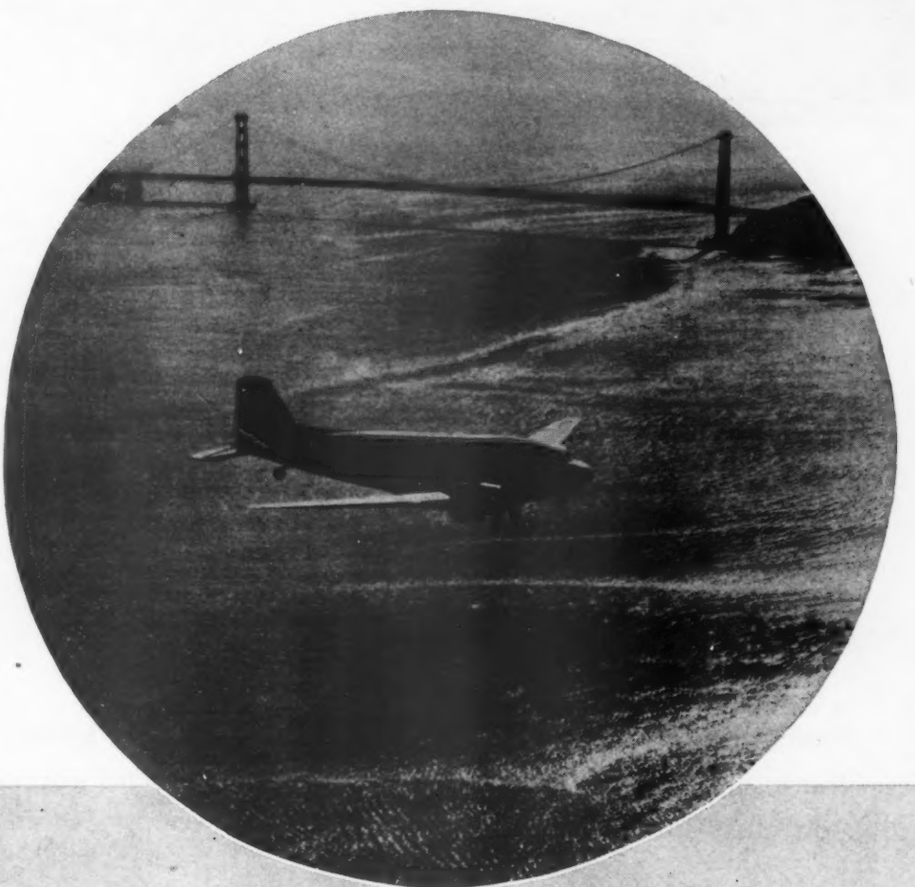
Another improvement in service was accomplished this year through a flight control center in Kansas City which facilitates handling of passengers, mail and express.

There has been no let-down in our training of flight crews and the men hired as first officers have requirements far exceeding the minimum qualifications. Records of a group of 50 first officers recently employed by TWA show that the average solo flight time for the group was 933.9 hours, the average age 25.9 and the average intelligence quotient was 104.5 as against a so-called desirable grade of between 90 and 110. Sixty-four percent of these men have had one or more years of college and 20 percent are graduates of an accredited university. The average attended college 2½ years.

In respect to age, it is well to remember that young men now qualified for airline work have been flying for years and they were able to pile up more hours in their youth than my generation of fliers did in theirs. Many of them have been flying since they were 15 years old. The average total hours of flying experience of first officers prior to employment by TWA is approximately the same as a year ago. In addition, more training has been provided, including a complete course of instrument instruction.

The biography of old 301, the father of the Douglas DC-3 transport, which

(*Turn to page* 315)



*After a tremendous record of achievement during the past seven years of unprecedented airline growth, there was never any question but what the DC-3 could be depended upon to handle a vast amount of wartime traffic. One of the principal reasons for this is that it is a maintenance man's airplane—designed for easy maintenance.*

*Press Association photo*

# We Learned War Maintenance With the AVG

*Press Association Photo*

**Peacetime maintenance methods apply on the battle fronts up to a point. From there it is a matter of learning the hard way. And you must learn quickly to survive—you must survive to keep 'em flying.**

*The author in front of operational headquarters in China.*

By TYE M. LETT, JR.

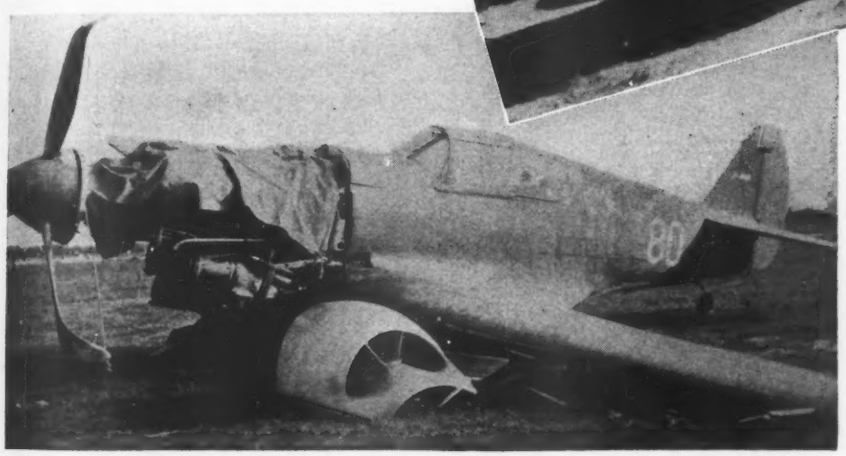
*Overseas Representative, Allison Division of General Motors*

GLOBAL WARFARE, requiring the operation of military aircraft thousands upon thousands of miles from the place of its manufacture and the home nest of spare parts, is creating new concepts and imposing heretofore unheard of conditions upon maintenance and service. Certain basic principles of the all-essential effort to "keep 'em flying" remain as good and as sound as in the days when they were evolved in peacetime operations. Truths discovered, and sometimes too quickly forgotten in the easier times, emerge under the stress of war as shining commandments never to be violated.

Holding to these truths in the very first organizational stages of developing a program of maintaining and servicing an aerial combat force on some distant fighting front, the pattern of actual operation is likely to change under the exigencies of war until in many instances it will have little resemblance to its peacetime counterpart. All of this and more we of the Allison Division of General Motors, who were permitted to assist in keeping up to fighting standards the equipment of the Flying Tigers of the American Vol-

*Press Association Photo*

***Dispersal of maintenance centers was the key to survival. Only simple ground servicing was performed at the operational field. Chennault's order was that "if a plane cannot be prepared for flight within 15 min., it should be withdrawn to a dispersal point for servicing by other maintenance personnel."***



***"Cannibalism" was developed to a fine point. Here is an "enemy operated on" P-40, retaining its high value to the AVG as a source of spare parts.***

*Press Association Photo*

unteer Group in China, have learned under the stress of battle.

For instance, in the type of warfare waged in that theater of hostilities—and the same will apply in the Libyan desert, in the wilds of New Guinea, or in French Equatorial Africa—one fixed base for all supplies and materiel is out. Nor in global warfare should a single, fixed line of communication back to the home factory, half a world away, be depended upon to bring up spares and replacements. We learned this latter lesson the hard way once when for a much needed shipment of spares for the AVG we designated but one delivery point—Rangoon—and the shipment was only half way there when the Japs closed that port. To the best of the writer's knowledge the shipment wound up in Karachi, where we were never able to get our hands on it.

### Home Representatives

On the other hand regardless of the state of the world—whether at war or at peace—no field representative setting forth on a maintenance assignment would think of leaving his factory without first designating a home representative fully conversant with the special problems in the field, who would always be on hand to follow through on orders, to see that they were filled as quickly as possible and to see also that the required materials kept flowing to the scene of operations.

This first and basic truth of service we did not overlook when, early in the program which resulted in the creation of the AVG, the Chinese asked Allison to undertake the engine maintenance for the fleet of Curtiss P-40's, powered with Allison V-1710 C-15's with which the Flying Tigers later established a combat record which has no peer in World War II to date.

General organizational plans for our service mission, which included extensive Washington conferences, were worked out by O. T. Kreusser, director of Allison Service and Training Depart-

*Press Association Photo*

***First and Second Echelon maintenance were jobs requiring less than 15 min. Work beyond this was carried on at secret dispersal bases. Here is E. A. Janski of Chicago checking propeller pitch "somewhere in Asia."***

ment, who had had experience with such problems in the last war.

Col. Chennault early indicated his desire to recruit a unit of United States Army and Navy crew chiefs. When this plan materialized the selected crew chiefs underwent a month's intensive Allison training at Indianapolis. These became the nucleus of the AVG ground crew. Later eleven Chinese, most of them American born, who had aeronautical experience either in college or practical operation, took six weeks of training at Allison. It was with these men, who were indeed an industrious and competent bunch, that Allison found that we could count on real Chinese ability. These men had factory experience and had contact with the assembly and acceptance tests of spare engines, obtained by the Chinese and destined for the defense of China. All of them quit good jobs to put their technical skill into the fight. Nine of them got through to China and became the backbone of our Third and Fourth Echelon maintenance and overhaul crews at Kunming and Loiwing.

But in all of these preliminary arrangements we did not forget that all-essential factor—the home base trouble-shooter. To fill the role of anchor man for our mission (and incidentally because it was a Chinese one) we selected N. C. Liu, a graduate in aeronautical engineering from Purdue University. It was Liu's intelligent planning when we were gone and his efforts, working against transportation difficulties, red tape, delays and the rising tide of submarine threats, that expedited shipments to the Far East.

Not all that we ordered through Liu reached us and one shipment of engines and spare parts took 90 days from New York to Rangoon—normally a 35-day trip. But that takes us back to the problems imposed by war upon lines of communications; and the hazards of these affect what one should order in the field when on such a mission.

## Cannibalism

In China we found that it was usually the little bits and pieces that grounded airplanes; parts like distributor points, small screws, distributor fingers, spark-plug, insulator tips and the like—small parts such as these gave us the real headaches.

To "keep 'em flying" for Chennault's boys we developed the practice of making two flyable planes out of three or four wrecked or damaged ones. This practice we called "cannibalism" and we developed it to a fine art. Every time we pulled this trick I said a little prayer for American standardization and the interchangeability of parts, which is a highly-to-be-praised characteristic of Allison engines.

This "cannibalism" has a direct effect upon what you should order from the "Home Front" and upon that which those serving you there should be prepared to supply you. For in "cannibalizing" you pick up a lot of certain kinds of extra spare parts. A good example is valve springs. As a rule you will get overstocked on these. Also the particular conditions under which your planes are operating and fighting, even to those of the weather, will determine the character of spares resulting from cannibalization. You should begin to figure upon this early from the first experience gained in the particular theater in which you are operating.

*Press Association Photo*

***One of the many lookout stations high in the Burma mountains from which "cheeze it" was signaled when approaching enemy bombers were sighted. Operational fields were completely cleared of materials and planes-in-repair within 3 min. after an alarm was given.***

## Proper Appraisal of Parts Needs

Another truth of maintenance which appears quickly under the stress of war is that a large stock of all kinds of parts is not the answer to efficient field service. It would be better to have a large and varied assortment of the small bits and pieces available at the First and Second Echelons, for these are the parts usually most needed to put a plane back into action in a hurry. These vital First and Second Echelon parts should always receive first priority. The major parts, required by Third and Fourth Echelon operations, can be provided at longer intervals, and where quickly needed can be flown to hot spots of action in emergency.

A careful weighing of unit parts according to incidence of failure, of course, runs counter to the present unit system of setting up arbitrarily the number of parts needed to service an airplane for 60 to 120 days and multiplying that figure by the number of ships in the squadron. Too often the feeling is that parts are so vital that it is just as well to have them on hand though they are averages in certain categories. This is uneconomical in wartime when every part should be counted in man-hours and material.

Another wasteful practice that carries over from peacetime operation under ordinary laws of supply and demand is the practice of ordering 1,000 units, hoping to get 100. When, by chance, the squadron does get the 1,000 units—not the 100—there is a terrible consequent waste of labor, materials and transportation. And further it should be borne in mind that the squadron which receives the 1,000 units where only 100 were required may be dooming some squadron in another quarter of the globe to certain defeat.

## Dispersal Points

Next we come to the matter of bases, depots and satellite fields. We originally planned grandly and optimistically to have ten outlying field maintenance operations, four sub-depots and two main overhaul depots. Experience in the field quickly taught us the error of such thinking. On the well-proven theory that you should never put all of your eggs in one basket, one main central depot will not do. A number of more or less co-equal depots should be set up. One of these, containing a large part of the reserve pool, should be located as far back of the main front as possible, but at a distance easily accessible at the worst by air. The other depots should be so located as to be in positions to have knowledge of special conditions and the changes in those conditions as they may occur in the sur-

(*Turn to page* 316)

# Built to save lives!

BUILT for destruction — sure. But American planes are also built to *save* lives . . . the lives of our pilots and crews!

American planes are built with superior armor and fire power—equipped with precision instruments for every possible flight need—to take our men to objective *and bring them home again.*

Time after time, guided by instruments they fly hundreds, *thousands* of miles through pitch black night, through rain and fog and snow. They range deep into enemy territory and get *safely* back to base.

All of which adds up to one important reason why our Army and Navy Air Forces are proving more than a match for the Axis.

# DESIGNING FOR EASY MAINTENANCE

**Field service operator's work on Fleetwings BT-12 training plane simplified and speeded by cooperation of service and design engineering departments. This teamwork from the beginning has also proved an aid to production.**

By J. A. KNOX, *Service Engineer and* J. J. BOERICKE, *Project Engineer, Fleetwings, Inc.*

IT IS AXIOMATIC THAT an airplane design that is good from a maintenance point of view is also good from a production point of view. If the plane is easy to maintain and service then it follows that it is likewise easy to build production-wise.

With that thinking in mind we designed the Fleetwings basic trainer, BT-12—the first military airplane ever built principally of stainless steel—which we are building in quantity for the Army Air Forces. As much attention was given in the design stage to the need for ease-of-maintenance of this ship as to the performance characteristics. We realized at the outset that a basic trainer is in the air hour after hour, day in, day out, is handled by fledgling fliers most of whom have had less than a hundred hours flying time, and therefore has to be tough and rugged and easy to service and maintain.

Every airplane designer knows that there are two principal approaches to employ in designing a plane that can be readily serviced. First, an effort is made to incorporate into the airplane parts that are inherently service-free. An example of this is the use of oilless bearings throughout the control system of the BT-12. Unlike plain bearings, these bearings will never require additional lubrication—they are lifetime lubricated. Another illustration of this point is the instrument panel which, because of the fact that fluorescent lighting is used to illuminate the instruments, does not have the multitude of electrical connections that usually are present. The face of each instrument is treated with a fluorescent paint, the result being that the figures appear luminous in the dark.

The second principal consideration calls for the use of easily removable units, both in the interior and exterior of the airplane. Perhaps the most apt illustration here is the use of large, readily removable sections of fairing on the fuselage. The design of the BT-12 is such that the entire number of fairings, extending from and including the ring cowling to the tail post on both sides of the airplane can be removed in less than 5 min., giving ready and complete access from the ground to the engine, accessory compartment, controls, radio and electrical systems.

The advantages of this feature are obvious. Consider, for example, the radio installation. If this equipment were to be installed and serviced through the cockpit the job would be exceedingly slow-going due to the cramped quarters for operating. Another example is the use of disconnect plugs and receptacles in the electrical installation. Use of plugs makes possible separate electrical units, any of which can be installed or removed and replaced in the ship with the greatest of ease. There are no solder connections to consume time and trouble when the plane is being serviced.

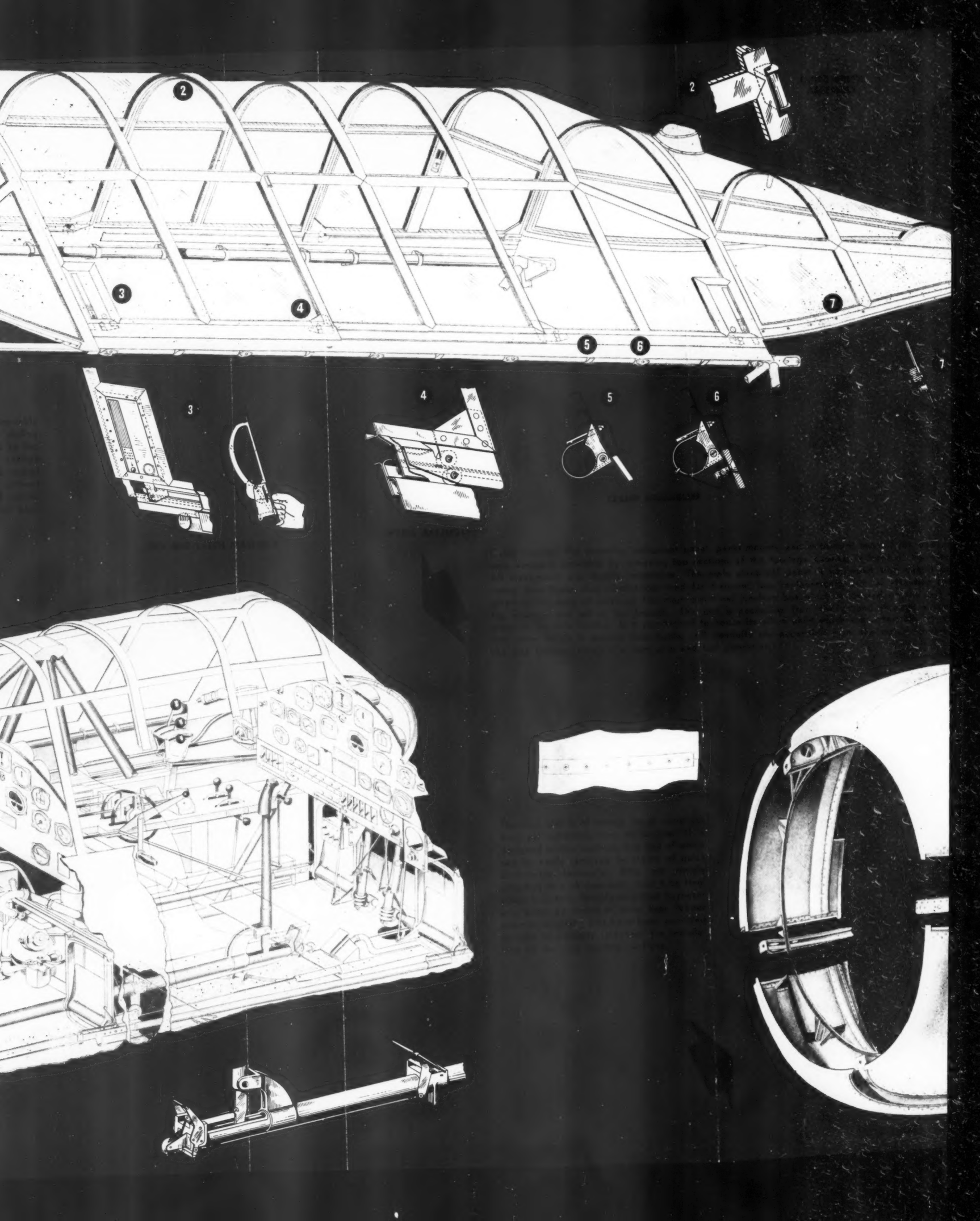
## Metal-Plywood Combination

The fuselage fairing is a combination of metal and plywood panels, each of which can be removed quickly by means of fasteners. From a service standpoint the plywood panels are very acceptable—almost any woodworker or carpenter can repair them. Airplane parts, other than fairing and like pieces, that do not require frequent and rapid removal, are attached by means of a prefixed nut which facilitates servicing. A special stainless-steel nut cap for retaining a nut in position on stainless-steel parts and which is replaceable, is specified in the design.

The illustrations that accompany this article describe—graphically—some of the more important easy-to-maintain features that have been designed and built into the BT-12. In addition to these, the following several points also deserve mention.

The entire engine section, including the engine, engine mount, oil system, exhaust manifold, and accessories, can be removed from or installed on the airplane as a complete unit, or the engine alone can be removed or installed on the engine mount. The engine mount is of conventional, welded, chrome-moly steel tube design, readily removable, and is attached to the fuselage by four tension bolts. Guide pins have been provided for hole alignment for ease of installation.

The tail assembly also reflects the fact that this airplane has been designed for simple servicing. For example, right- and left-hand elevators are identical, thus permitting stocking of only one part. Elevator hinge brackets can be quickly replaced by removing only two bolts.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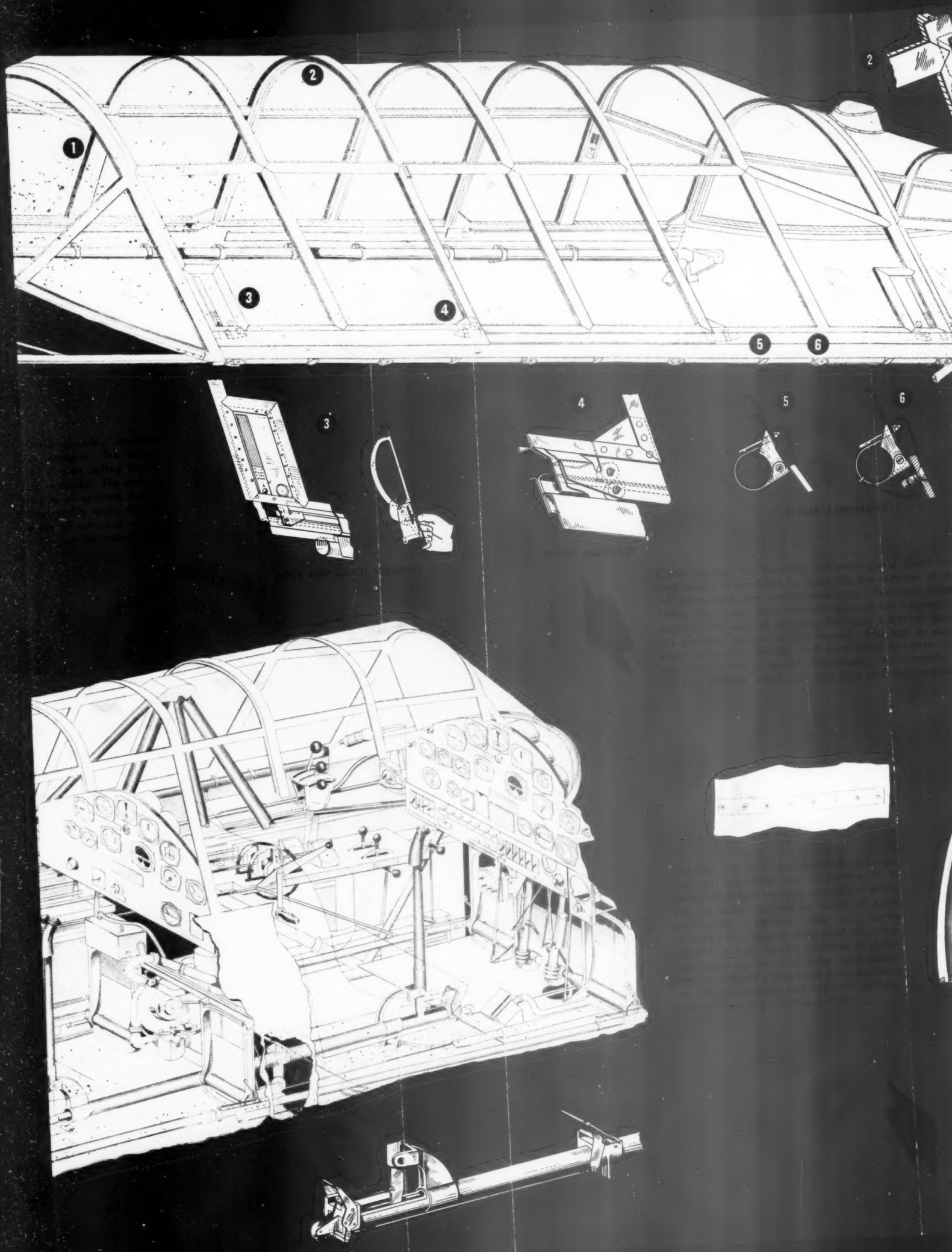
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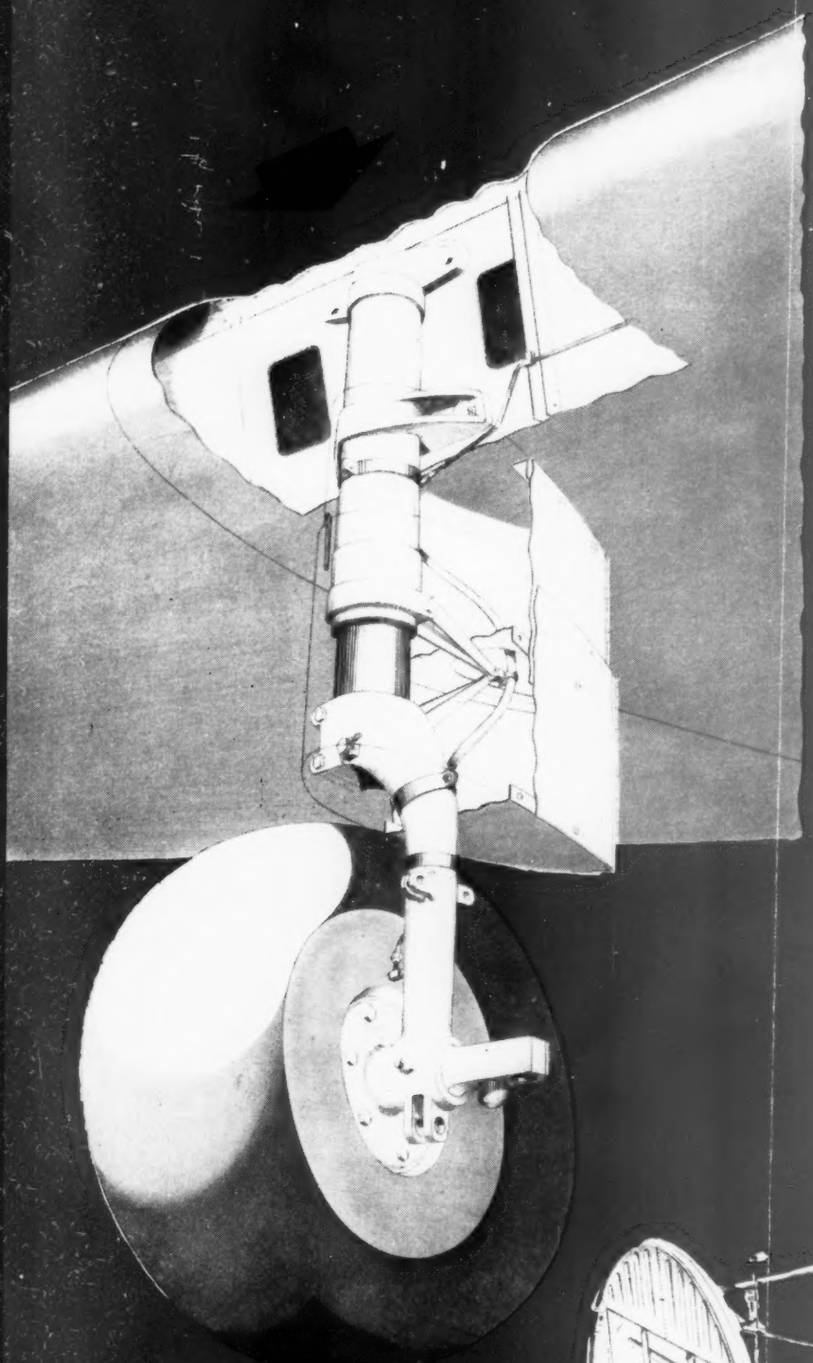
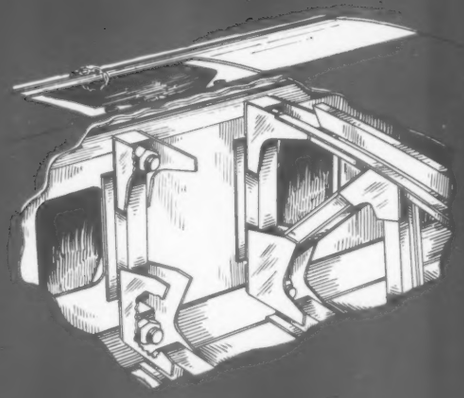
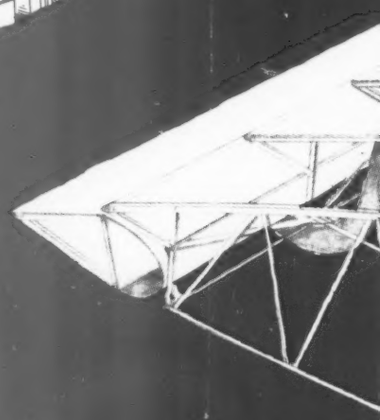
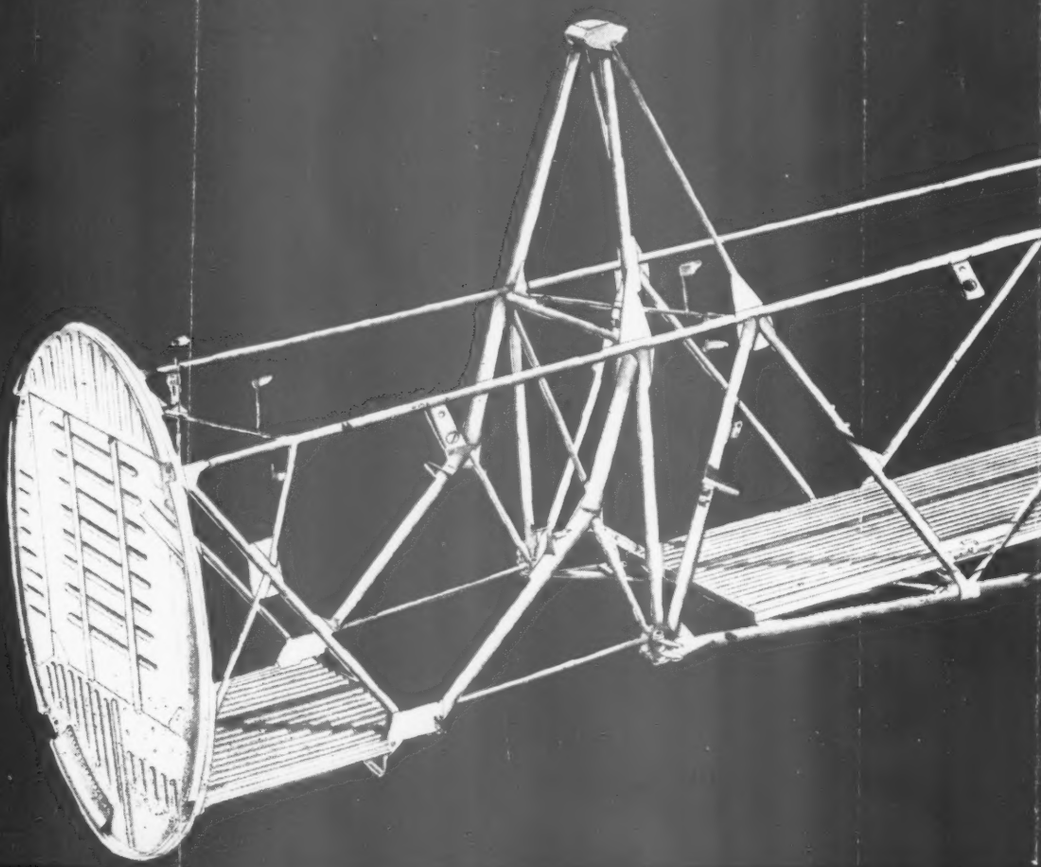
The landing gear of the Fleetwings BT-12 has been designed for ease of service and maintenance as well as strength. The cut-away below shows how the gear is attached to the front spar by four bolts through the metal fittings. The smaller illustration at top right is a view of the attachment at the spar from the rear, showing how the bolts go through the spar into the specially doubled ribs. The upper part of the landing-gear fairing is attached to the wing on an angle member and the extruded member while the lower part of the fairing travels with the wheel and shock strut.

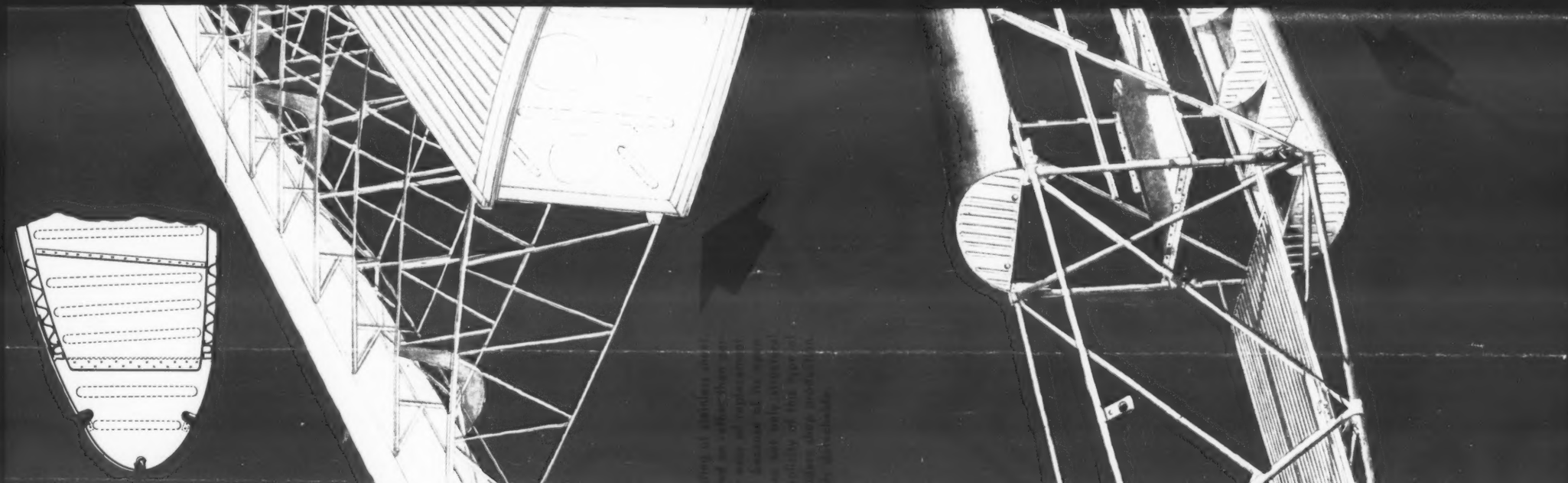






The outer wing panel is of stainless steel design consisting of stainless steel reinforced with corrugations. The leading ribs are bolted on [illegible] removably attached to the main spar which makes for ease of replacement. The entire trailing rib structure is readily repairable because of its open type construction. This stainless steel wing illustrates not only structural qualities of this material for aircraft but also the simplicity of this type of construction and shows as well its adaptability for modern shop production. The wing tip is of plywood construction and is quickly detachable.





...ing panel is of stainless steel design consisting of stainless sheet, ...with corrugation. The framing ribs are bolted on rather than per... ...manently attached to the main spar which makes for ease of replacement. ...The trailing edge structure is readily repairable because of its open... ...type design. The stainless steel wing illustrates not only structural ...possibilities of this material for aircraft but also the simplicity of this type of ...construction and shows, as well, its adaptability for modern shop production. ...The tail unit is of plywood construction and is quickly detachable.

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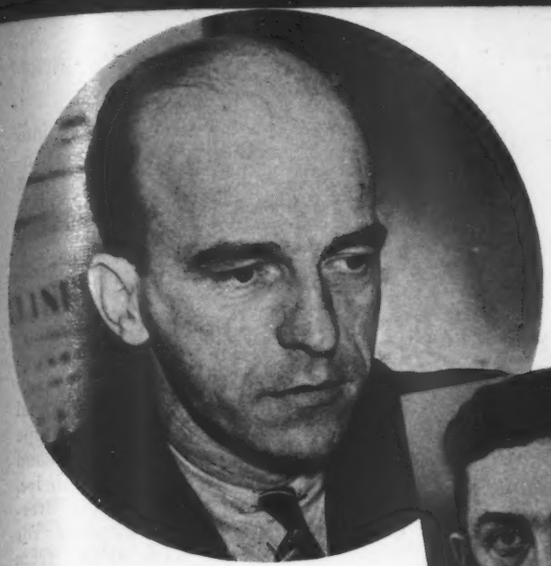


J. F. MARTIN, Supt. of Maintenance, American Airlines

FRANK WARE, Asst. Supt. of Maintenance, American Airlines

R. A. MILLER, Supervisor of Overhaul, American Airlines

American Airlines and Continental Air Lines have been selected this year for AVIATION's Maintenance Award. In keeping with the policy established last year, awards are being made to an airline operating over 100,000,000 revenue passenger miles per year (American), and one to an airline operating less than that amount (Continental). The awards are to be presented to the winners at the maintenance meeting of the Air Transport Association to be held in December.

# American and Continental Win Aviation's Maintenance Award

THIS YEAR the selection of AVIATION's Maintenance Award winners has been more difficult than ever before. The fact is that the maintenance departments of all the airlines are deserving of special commendation in view of their magnificent work under times of great stress. Despite the reduction of available equipment and loss of highly specialized personnel, airline schedules have altered but slightly and are being kept with amazing regularity. The maintenance function is directly responsible for this achievement.

The engineering and mechanical genius of the maintenance men has come to the fore as a military asset of the first magnitude. Almost every day, in every shop, a new idea, a new method, a new gadget is devised to increase maintenance efficiency and to make quicker turnaround possible. Where more time available is equipment available and more traffic handled, this characteristic initiative counts heavily when needs for carrier space are so real as in time of war.

Other factors, no less important, include a more efficient routing of ships so that maintenance shop load factor is greatly improved; the use of maintenance specialists which reduce maintenance time and simplifies training of new personnel; and rigid adherence to improved personnel safety measures which prevent maintenance delays.

Apart from keeping intact the nation's vital air transport service, which represents a major contribution to the war effort, the maintenance departments have assumed a considerable responsibility in the training of Army mechanics and in modification work. In this latter work, the engineering talents which have consistently been a major factor in air transportation progress are now employed in a war production function and can be measured in terms of distinct war material gains.

With their tasks multiplied threefold, therefore, highest tribute is due these men upon whom so much depends in time of greatest need and in whose efforts we find a symbol of confidence and security.

Typical of them are the maintenance personnel of American Airlines under Joe F. Martin and of Continental Air Lines under Stanley R. Shatto, whose companies are winners of AVIATION'S Maintenance Award this year.

RAY C. JOHNSON, Asst. Supt. of Maintenance, Continental Air Lines.

STANLEY R. SHATTO, Vice-Pres., Engineering and Maintenance, Continental Air Lines.

# WORLD CARGO Takes to the Air

## Some effects of world-wide operation of transport aircraft on maintenance and design.

By DONALD S. SPRAGUE

*Service Manager, Douglas Aircraft Company, Inc.*

WHEN the United States' entry into the war brought a sudden vast expansion of our air cargo systems, the DC-3 transport was already a familiar sight on the runways of every major airline and air force base in the Americas. Today—carrying the insignia of C-47's, C-49's, and C-53's—her sisters are roaring along airlanes to every continent of the world. Service experience in these new regions has taught many lessons, and our Maintenance Manual now reflects the changes made to cope with African sands, Newfoundland snow, Australian heat, and Alaskan ice.

The outstanding problems to be overcome in providing an airplane for world wide service have arisen from new combinations of the factors of weather and geography. Although there are in the United States localized examples of practically every operational condition to be found elsewhere, we have not before been forced to operate over such large areas, not counties, but continents of sand and heat, or over an area, not a snow covered province but an ice-laden ocean with mud-splashed islands for airports. Because of the scope of the problems that have arisen, it will not be possible, here, to consider each item in great detail. We feel, however, that the following will cover the highlights and may assist ground crews to more thoroughly investigate the items which may affect their work.

The problems inherent to arctic operations have been among the most difficult, although operators in the northern United States have already battled the problem for several years

*Acme photo*

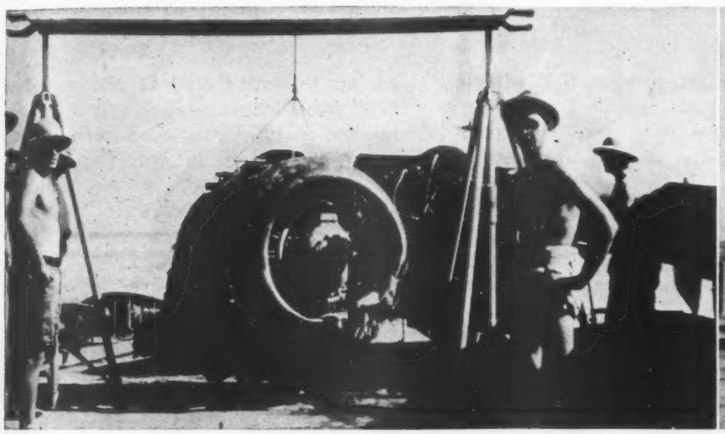
***This Douglas C-53 transport and the grass hut in the background provide a striking contrast which is no longer unusual in Africa. The hut stands in the path of an airport runway, and will soon be demolished to make way for construction.***

*Douglas photo*

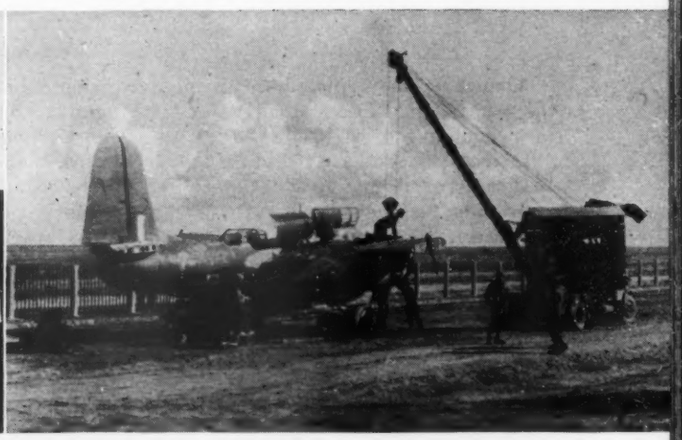
***Contrast this scene at a domestic air base, with clean paved runways, ladders, carts, and service trucks, with the pictures opposite showing typical conditions encountered in Africa. Douglas A-20's are being serviced.***

*Assembly and service behind the lines in the desert. Refueling is a matter of emptying hundreds of tins of gasoline but the empty tins come in handy as work stands. Note mechanic in background standing on one.*

*In the heat of the Middle East, the pause for tea is not only welcome but a downright necessity. Douglas crewmen, James A. Woosley (left), propeller specialist, and Henry Kaehler, in charge of financial matters, are served by a native army mess attendant.*



*At some of the bases modern equipment, such as the jacks shown here, is available. Douglas crewman, Jack E. Jackson (right), helps salvage a North American B-25. All Douglas men work on all types of ships, regardless of make, in their hunt for useful information.*



*In the desert downed planes are not always salvaged as easily as this one because mobile cranes and derricks, such as this one, are not always available. In that case, materials at hand plus ingenuity must accomplish the job.*

and laid a groundwork of experience. It has now become necessary to incorporate into production the requirements previously applicable to a comparatively limited number of airplanes. Design changes and maintenance practice now affect a large number of transports operating under even more difficult cold conditions. Consequently the Douglas company has been endeavoring to offer maintenance suggestions on transport airplanes already in the Arctic, concurrent with our development of a broader "winterization" program to provide complete cold weather protection for a certain percentage of our production airplanes.

The most immediate points of attention center around the aircraft insulation for the reduction of heat losses due to radiation, and the ventilating and de-icing systems. On the one hand, it is necessary for all ground and flight crews to be thoroughly familiar with the instructions for operating and maintaining the heating systems. At the same time, because of the increased importance of these systems, it becomes necessary for the manufacturer to concentrate even more on simplification of their design and maintenance.

There is now a tendency to draw away from the use of the earlier steam heating units which have been standard for the past several years. Under new operating conditions, which may be expected to be well below zero, condensation and freezing of water have become prohibitive problems, along with the procurement of steel alloys satisfactory for use in the heaters.

The new Stewart-Warner internal combustion heaters are now being used with some success, but it is not clear yet whether or not such a gasoline-flame heater is the final answer to maintaining satisfactory temperatures inside the airplane.

A heating system, using hot air drawn from a muff-type heater around the engine exhaust stacks, is also under consideration. This heater has been used quite successfully by one operator recently, and since such an installation could have considerable advantage from a maintenance standpoint, it is being closely investigated.

Using a hot air system for wing deicing is also receiving much of our attention. Although the past use of the "balloon-type" rubber de-icer boots has given much satisfactory service, we have found that the effect of extreme cold on rubber, coupled with the requirements of higher speed and performance, justifies our investigation of an alternate method for ice removal, such as heated air passed through the wings.

Arctic maintenance men are now becoming familiar with the new alcohol feed shoe appearing on the leading edges of the propellers of many "winterized" airplanes. These shoes serve the purpose of guiding the anti-icing fluid further out along the blade. Extreme cold has fostered wider use of this additional de-icing device. At the same time, long-range operations at

*Native crews, such as these two shown checking over a wheel on a "Boston" that is undergoing repairs, have to be trained and supervised. The problems imposed by the desert's heat and sand are augmented by that of available skilled labor. Under such conditions the miracle of American aircraft excellence becomes an even greater one.*

*Douglas field men train native mechanics, such as these from the Indian Army, to assemble, maintain, service and repair Douglas-built aircraft, such as the A-20 or "Boston" shown in the background. With sand for a floor and blocks of wood for jacks, field service has to be resourceful.*

economically low rpm. have reduced the centrifugal forces that assist in throwing off the ice itself.

Incidentally, we have found that these feed shoes require no great maintenance, and with reasonable care, are easily installed. Small nicks or cuts in the rubber may be dressed out with a knife and, although the item should be checked by engine run-up, the balance of the propeller is seldom seriously affected by small pieces cut from the shoe.

Preheating of engines and accessories before starting is a matter of great importance, but one in which much experience has already been gained. Several units are now on the market providing portable hoods to supply warm air to preheat the engines. It has also been found necessary to warm the engine accessories to insure their free operation upon starting.

At this point we might mention that if you have been having trouble with fouling spark plugs and a rough-running engine, perhaps due to using plugs other than those specified for the engine or plugs that are dirty, your troubles have only begun if that combination of engines and "cold-running" plugs is taken into the Aretic. To assure prompt starting and smooth running, it is imperative that your engines have the plugs specified by the engine manufacturers for those operation conditions. This also applies to using correct booster units.

In the past year special lubricants have been developed giving improved service and freedom from freezing. Some of this development has been brought on by earlier instances of lubricants freezing on such installations as control tab drums and gear boxes, brought about by extreme cold, or high altitudes. Lubricants are now available giving satisfactory operation with temperatures in the region of —75 deg. F. and particular care should be taken to insure that the proper lubricants have been installed, particularly if the airplane is a new arrival in cold climate. These special greases are now regularly installed in all production airplanes which are given "winterized" treatment in advance.

Many of the operators are already acquainted with the activities of Douglas' experimental research "cold-room," and much of the data leading to "winterization" changes has been developed or verified in this laboratory.

We are now lubricating such control bearings as tab drums, gears and gearboxes with grease to conform to Army Specification AN-G-3. Beacon M-285, product of Standard Oil of New Jersey, has been found satisfactory for extreme cold weather operation. Douglas practice is to identify such sealed bearings with cold weather grease by blue paint on the seal-disks. On units carrying heavy bearing loads, such as main landing gear wheel bearings, a medium, fiber-base grease is used conforming to Specification AC 3560.

Oil dilution systems have become a standard part of the provisions for cold weather operations. When it is anticipated that an engine will be very cold at the time of re-starting, gasoline is allowed to run into a "hopper" within the oil tank for a few minutes prior to stopping the engines. In subsequently starting the engine, this diluted oil is fed first to the system, providing more immediate lubrication of engine bearings by avoiding the sluggish action of congealed oil of the viscosity necessary for normal operation.

With this principle in mind, maintenance men and operators should remember not to leave the oil dilution switches "on" for a longer period than is recommended in the maintenance manuals, as this would over-dilute the oil with a possibility of a dangerous loss of lubrication through the presence of *too much* gasoline.

Attention has been given to insulating pipelines carrying oil by lagging them where they may be subject to freezing temperatures. "Winterized" airplanes can often be most easily recognized by the lagging around the oil tank, as located in the engine nacelles on the C-47's and the C-54's.

Experience has shown that lagging of lines forward of the firewall is unnecessary, and may even present adverse conditions.

Maintenance men will bear in mind the item of the difference in thermal expansion of various methods and materials used in aircraft construction. This is a problem which Douglas has had to consider in "winterizing" its airplanes and one which may sometimes explain unusual instances of looseness or interference on assembled units. Since the coefficient of thermal-expansion for the usual aluminum alloys runs roughly 15 to 30 percent higher than for steel and brass alloys, the influence of extreme changes of temperature on dural will be correspondingly greater than on such other metals.

This accounts for the necessity for specialized cable rigging charts applicable under extreme cold weather operation. Should an airplane whose cables have the proper tensions under cold weather conditions be shifted to a temperate or tropical region, it will be noticed upon rechecking cable tensions that the loads are high and the cables must be slackened a bit to prevent excessive pulley wear or cable fraying. Ths is obviously due to the increase of

temperature of the aircraft: The aluminum structure has expanded more than have the steel cables, thus giving a greater tension in the cables.

The effect of thermal-expansion also contributes greatly to the performance and maintenance of shock-absorbing oleo struts. Instances have been noticed where an oleo strut had the proper inflation while the airplane was standing in a warm hangar. When the plane was subjected to an extreme temperature drop on the field and in flight, the contraction of the air within the oleo allowed it to go "flat," eliminating its shock-absorbing function.

The deteriorating effect of extreme cold upon rubber is also influencing modern design, and we may endeavor in the future to cut down the use of rubber bungees in favor of mechanisms with a longer life under extremes of temperature.

The presence of mud and slush, although by no means limited to arctic operations, is of particular significance under those conditions. Considerable attention by maintenance men is necessary to insure that parts subject to the spray of mud and water are kept as clean as possible to cut down the possibilities of mechanisms becoming dirt-clogged or frozen. We have found that a coating of low temperature greases and oils will improve this condition. This maintenance item applies especially to the nacelles, where there is a danger of blocking the action of landing gear safety latches and warning light switches.

The above has dealt with problems particularly accentuated by cold weather operations. Obviously, these problems are not limited to cold weather, and on many of them a complete reversal of temperature into the tropic zones brings on a contrary condition which is just as much of a headache to maintenance men and to the manufacturers.

At the time when tropical operations became a major part of our air cargo system, there was considerably less experience available than was the case with arctic operations. With some, the difficulties of tropical operations were largely centered around ground handling and maintenance under sun temperatures running up to 170 deg. F. and 180 deg. F. and shade temperatures between 120 deg. and 140 deg. Even more of a problem than the temperatures are the sand and dust storms against which airplanes on the ground have to be safeguarded or serviced.

The first maintenance move found necessary was in combating sand storms. In United States operations, we have generally been able to skip areas of desert, spotting our airports at major towns with adequate protection and

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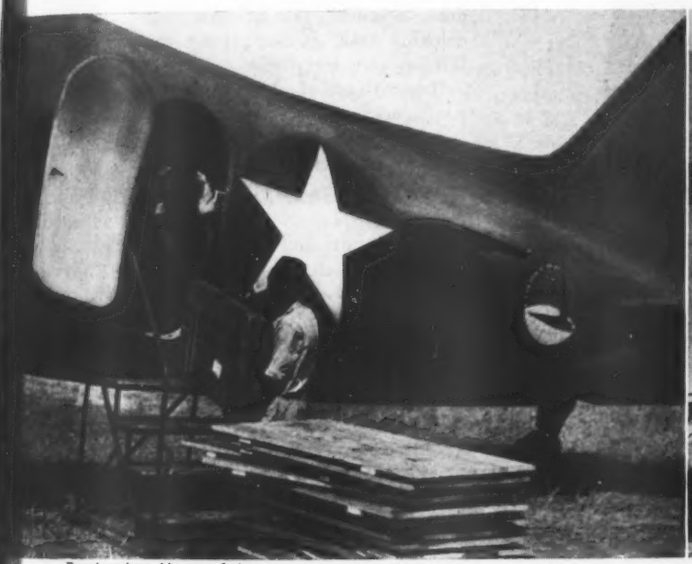
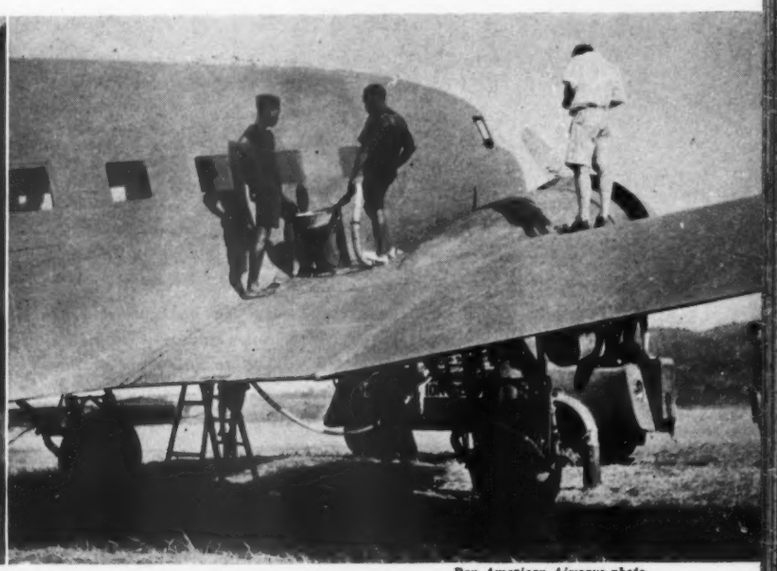


*Pan American Airways photo*

*Douglas C-53 of the U.S. Army Air Transport Command takes on a load of prefabricated lumber for delivery to an advanced base. Vast amounts of men and materials have been moved by air throughout North Africa.*



*Pan American Airways photo*

*Manpower has been one of the most serious problems encountered in African transport operations. However, natives were put to work, given training, and many proved capable of handling many jobs.*

*Acme photo*

*Hordes of natives are engaged in building airports in jungles and deserts of Africa. Despite primitive methods and lack of modern machinery, prodigious construction feats have been accomplished. Note Douglas transports in the background.*

THROUGH GRAPHIC "before and after" perspectives, the tremendous development of wartime aircraft maintenance may, in some measure, be visualized. And how amazingly the picture has changed since that "before"!

Just a month prior to Pearl Harbor, I prepared an article titled The War and Aircraft Maintenance (AVIATION, December, 1941) and little did I, or anyone else for that matter, realize then how strikingly soon the presumptions of that study would come to pass.

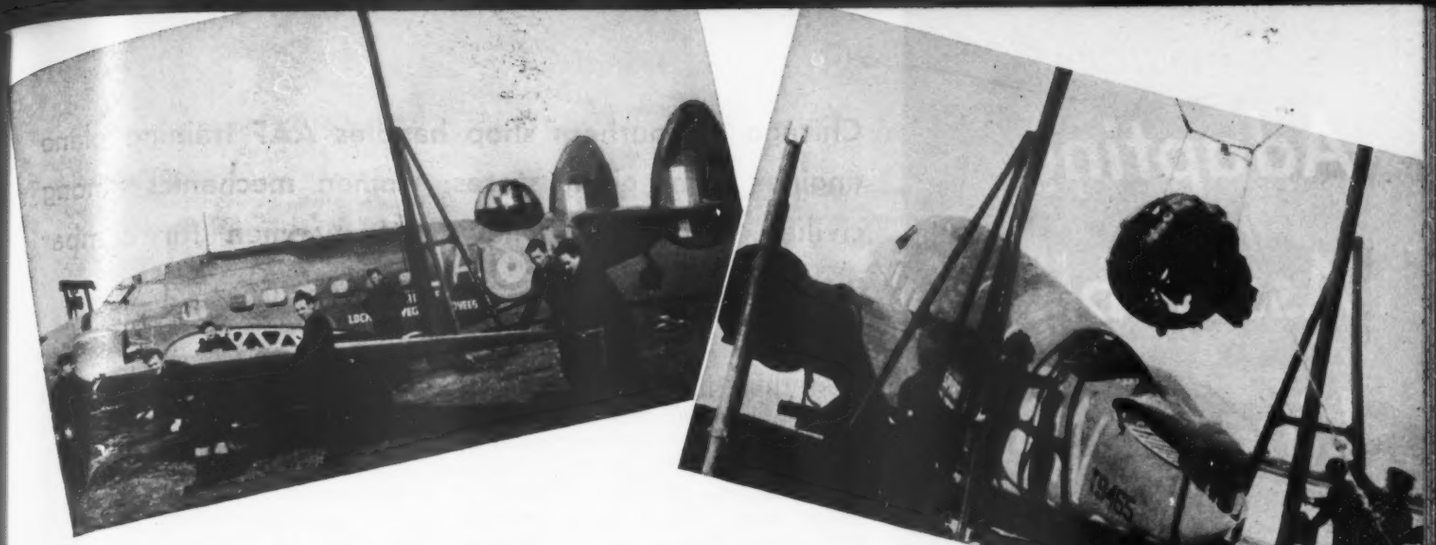
Then I talked of 12,000 airplanes—but today we are on the home stretch to a 1942 production goal of nearly five times that figure! Surely, none but the very best informed can begin to gage the utterly fantastic amount of planning and work required to keep our gigantic air armada in condition and ready for combat. Certainly the biggest technical job of this war is the colossal task of supplying and maintaining our warplanes.

Regardless of how outstanding its performance may be or how ruggedly it may be constructed, an airplane is only as good as the maintenance it receives. Our index of production is not

*Back into blue over Iceland—again airworthy and fightworthy! Damaged in forced landing on rugged beach, this "Hudson" was quickly dismantled, taken by float to freighter, shipped to near-shore overhaul station, speedily repaired and reassembled by field maintenance crews.*

*Maintenance of thousands of warplanes depends on steady flow of required parts. Completely equipped trailer units—like this one of Technical Training Command—carry mockups of aircraft operating systems, circulate from squadron to squadron.*

# *Fighting the AIRCRAFT MAINTENANCE War*



*Field problems are solved with "forced draft" ingenuity. Here are repair and reassembly close-ups (above and right) of landing-damaged "Hudson." Note practical, portable crane. Below: "Flak" was flying—and this plane "took it." Intricate overhaul questions are posed by such battle battering, but factory-trained servicemen find answers "on the double."*

the factor that determines how many aircraft can be placed in combat. That factor can only be calculated by an analysis of the number of aircraft in condition to fight—and the fighting condition of an airplane depends entirely upon how well it has been maintained.

Aircraft maintenance has undergone a vast change from both the air-line and military maintenance we knew a few years ago. Granted, the same fundamental operations must be performed now as then. But now, instead of maintaining a few hundred aircraft within our continental limits, we must maintain thousands of them in the heat of Libya, the jungles of the Solomons, or the snows of northland bases. This global war, evil though it may be, has packed years of experience into the space of a few months.

Where a maintenance problem in the past was the subject of careful deliberation and experimental work involving weeks, we must now make decisions quickly—and act. Our very salvation depends on action. And an amazing truth is noted when we compare the results of these fast decisions with those past results founded in careful deliberation: Our wartime results are just as good now as they were then. Perhaps it is a success born of our knowledge that besides acting fast, *we must be right the first time.* The planes must be both airworthy and *fight*worthy!

In writing of maintenance last year, I named four cardinal necessities of successful military aircraft maintenance: (1) Maintenance bases and equipment, (2) parts supply and distribution, (3) trained personnel, and (4) transport. There are, of course, multitudinous ramifications surrounding each of these requirements which, drawn in detail, would fill volumes. These needs were noted before Pearl Harbor. Now, a year later, it is interesting to note the rapidity with which the requirements for each of these major maintenance necessities have been fulfilled.

Here's an example of the speed with which Army Air Forces maintenance bases have been established:

On Dec. 3, 1941, the AAF asked the Lockheed Aircraft Corp. to establish a maintenance and overhaul base in a foreign country. This base was to be

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**Score upon score of bases, both permanent and mobile . . . myriad parts and equipment . . . air transport to take then anywhere . . . trained personnel throughout to gather, distribute, and apply them rapidly, accurately. A fantastic order—but the ASC is filling it!**

By REAGAN C. STUNKEL

*General Service Manager, Lockheed-Vega Aircraft Corporation*

# Adapting Assembly Line Techniques To Engine Overhaul

**Chicago & Southern shop handles AAF training plane engines from eight states; women mechanics among civilian employees relieving Army men for combat plane work.**

ASSEMBLY LINE TECHNIQUE is being used in the Army Air Forces motor repair depot now functioning in Chicago & Southern Air Lines' shops at the Memphis Municipal Airport.

This depot handles Army training plane engines from a territory bounded by Florida, North Carolina and the Mississippi River, taking in eight states. Several of these repair stations have been set up throughout the country to relieve the regular Army depots of this work and allow them to concentrate on engines for combat planes.

Civilian mechanics, a few of whom are women, are employed on this project and are under direct supervision of both Chicago & Southern and the Army. The fact that training plane accidents due to motor failure are practically nil attests to the thoroughness of their work.

"Chicago & Southern has developed a production line that is now ready to 'click'," according to Capt. Richard E. Fly, Army Air Forces Control Depot representative, through whose office the work is handled. "This is due both to good management and to having good men working on the project. We started this work recently on a small basis and now we are ready for production—to get the maximum number of engines off the assembly line each day. Our goal is to handle more than 100 engines per month."

A number of mechanics working on

*Assembling a Continental R-670-5 engine by production line methods gives speed through which the base expects to overhaul up to 100 engines per month. Use of civilian employees, including women, under Chicago & Southern and Army supervision relieves Army Air Forces mechanics for concentration on combat planes.*

*Chicago & Southern Air Lines photo*

the project were trained at the National Defense School, and more now in training there will be employed. As production increases, more and more women will be employed to do this mechanical work, Capt. Fly has reported.

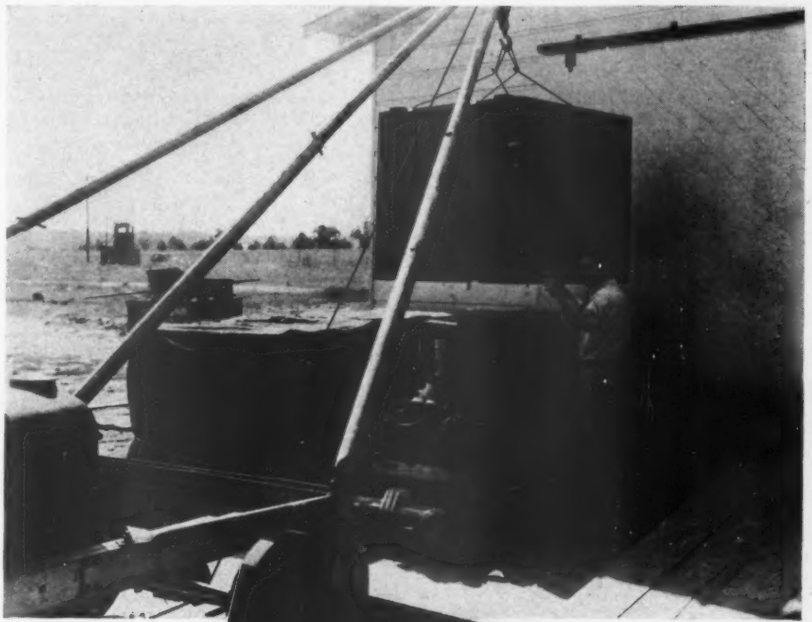
Among the outstanding achievements in connection with this repair depot is the development of a portable motor test stand which saves approximately one man-hour of work per engine. It is the first such test stand of its kind in the United States, and was designed and built under the supervision of W. L. "Doc" Anderson, C & S superintendent of engineering.

After the engine is assembled, it is bolted to the portable test stand and rolled to the specially built test house where the stand is locked into place. Each motor is test run for 5 hr. and 45 min., during which time it is constantly checked by instruments and its performance recorded.

Every 500 to 600 flying hours, each training plane engine must receive a major overhaul, consisting of completely disassembling the engine, cleaning it and inspecting each of its many parts for wear or defects. Worn or defective parts are replaced and the engine is put together again along the assembly line. After the test run it is crated and shipped.

Both the engine overhaul "assembly line" and the test cells are housed in specially built quarters entirely separate from Chicago & Southern's regular maintenance department.

*Continental engines from Army Air Forces training planes reach the Chicago & Southern repair depot by truck in special crates used for shipment both ways. Here Henry Whitehorn, C. & S. mechanic, supervises crating of an engine which has just finished its test run after complete overhaul, ready to go back into service in an Air Forces training craft.*



*An outstanding development at the engine repair base is the portable engine test stand designed by R. L. "Doc" Anderson, superintendent of engineering, which saves approximately one man-hour per engine. The assembled engine is bolted to the stand, which is then moved to the specially built test house and locked in place.*

*The Army Air Forces engine repair depot at Chicago & Southern Air Lines base uses production line techniques in overhauling training plane engines from Army schools in eight states. Capt. Richard E. Fly, AAF representative, watches a cylinder specialist at work on one section of the "line." Success of the technique "is due both to good management and having good men working on the project," Capt. Fly reports.*

# O'er the ramparts we watch

LOOKING down now on our embattled America is the spirit of the undaunted men who guided this nation through the perils of the past.

They see our mighty republic, nurtured by liberty and union, menaced anew as the guardian oceans shrink and the ramparts we manned become targets instead of barriers under the speed and power of attack from the air.

Once, all that courage needed was a foothold for the defense of its homeland – by protecting its harbors, rivers, mountain passes and vital points, it could protect the whole.

Then the sinking of the Spanish Armada ushered sea power into full reign and, spread and fed by strategic bases like Hongkong, Singapore, Gibraltar, Malta, Alexandria and Capetown, sea power was made to mean world command.

NOW as in the twinkling of an eye all this is changed!

Land power and land barriers however formidable are hurdled and overcome. Sea power with all its far-flung majesty is threatened. The third and decisive dimension – the ocean of the sky – is mastered by the plane, overleaping on land and sea all the barriers of the past.

So the ramparts *we* watch are overhead, and our vigilance must comprehend not just the curve of our shores but the arch of our heavens; and one freedom crowning and determining all other freedoms for ourselves and our children is henceforward the freedom of the skies!

We must be strong there. Nay, we must be invincible, dominant! Time, now telescoped by speed, requires it. The days of grace we once knew by virtue of the slow pace of armies and weeks-long distances of the seas are briefed by the planes to hours.

To preserve America *we must make her first in the air* – prepared in advance to defend and attack at any point, her strategy mature and universal, her youth trained, ready, dauntless, their equipment and tactics the very perfection of the newest art in war.

We must be air-minded, fair-minded, world-minded now – girt in spirit and strength to the new leadership destiny is placing in our keeping – justifying our matchless future place and responsibility through justice to all.

In the light of these truths Goodyear is proud to be producing both complete airplanes and airships, as well as wing, tail and cabin subassemblies, control surfaces, wheels, brakes and bullet-puncture-sealing gasoline tanks and fuel lines for many of America's most famous fighter and bomber aircraft.

America *must be first in the air.* Before any other duty Americans must provide the means and weapons to put her there – else neither we nor you nor any of our people nor their children will ever be first in anything again.

GOODYEAR
AIRCRAFT

**AMERICA MUST BE FIRST IN THE AIR.** *Unless and until America is the most powerful nation in the air, our safety, our freedom, and our standard of living will not again be what they have been in the past.*

P. W. Litchfield

*Actual work on late model B-25 bombers, under the direction of two instructors, is familiarizing two groups of AAF mechanics with the jobs they will do in the field. To simulate field conditions, the men are not permitted to use the time- and labor-saving mobile cranes, hydraulic hoists, and other equipment commonly in use on all modern American airports. Instead they do it the hard way, as they will have to in far-flung corners of the earth.*

*Frank Lyons (left), field service manager for North American Aviation, Inc., gets a personal report on the performance and service problems encountered by P-51 "Mustang" fighters in the European combat zone from Phil Lagarra, the company's chief representative in London. Lagarra had just returned from his post for a short stay at the home plant to amplify his field reports and be brought up to date on new developments for the "Mustang."*

# Bringing Field Experience Back to the Plant

**Three-fold program coordinates manifold jobs of North American Aviation's field service representatives to insure maximum performance of planes on all fronts.**


By FRANK H. LYONS

*Field Service Manager,*
*North American Aviation, Inc.*


AMERICA'S WIN-THE-WAR production program, calling for an enormous output of aircraft, has made it necessary for North American Aviation and the aircraft industry in general to expand manufacturing facilities almost beyond conception. Yet in spite of the thousands of airplanes being built in this nation, the tremendous effort put forth to get them into service would be a futile gesture if they were not kept in flying condition. North American therefore established a unit within its organization whose sole aim and responsibility is to coordinate operational and maintenance information between the home plant and the pilots and mechanics operating and servicing B-25 *Mitchell* bombers, P-51 *Mustang* fighters, and AT-6 combat trainers in the field. Thus was born the field service department.

An airplane on the ground is of no value in fighting so in order to keep our airplanes in the proper operating condition three methods are employed:

First, by an on-the-spot educational system, as practiced by the company's highly specialized and thoroughly trained group of 40 field service representatives who are assigned to posts throughout the world.

*Inside and outside, from propeller hub to rudders, AAF mechanics are taught by North American experts how to service, adjust and repair airplanes produced by the company and to which the men will be assigned in the field. Their education will be continued at the fronts by other company experts of the field service department who will bring them up to date on late developments and send back to the plant the discoveries these AAF men make that are of value.*

Second, by a factory training program for the United States Army Air Forces personnel.

Third, by the preparation of flight, service, and repair manuals, which are used by the pilots and mechanics all over the world.

An extensive educational program is provided for our field service representatives, who, during the past twelve months, have traveled more than 250,000 mi. and checked up on our airplanes in service in 22 countries. Their training recognizes that their job is twofold: (1) As just mentioned, to give on-the-spot information on the proper technique for operating, servicing and repairing North American planes, and (2) to report their findings to the home office.

A close watch for any and all signs of trouble is maintained by each man. Operation and service problems raised by climate such as the high temperatures of the desert, the low temperatures of the Arctic, the effects of humidity in the jungle, or of sand and dust, mud, ice, bugs or vegetation—all of these are reported to the home office. These reports are indexed and forwarded to the various engineers responsible for the design of the airplane and, if the same type of difficulty is reported from different combat zones, steps are immediately taken to improve the part in question in order to prevent recurrence of the trouble in planes on the production line.

This procedure has proven extremely helpful in keeping planes we manufactured in the air, a fact emphasized by reports on their excellent performance in New Guinea, Egypt, Burma, and over other battle fronts throughout the world.

The men selected as field service representatives are picked from among employees in our plants who qualify on the basis of their knowledge and experience with our planes. The first requisite is that men be thoroughly familiar with North American airplanes. We likewise prefer that they have a background of engineering experience. This is desirable as our airplanes do get hit by enemy bullets and, since these

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# WOMANPOWER

# In Airline Maintenance Shops

By CHARLIE N. (Jimmie) JAMES
*Vice-President, Operations, Western Air Lines*

*Mrs. Sally DeLong, Western Air Lines' "draftsman", and wife of a research engineer, discusses plans for passenger facilities changes with Russell J. Smith, manager of reservations service in Los Angeles, as A. Letcher Seamands (center) chief passenger agent, looks on. Other women are being trained for mechanical jobs, as electrical and instrument technicians, radio operators, and reservations clerks. The company's news bureau has long been conducted by women who do all phases of its work including photography.*

**SINCE LAST DEC. 7 when the United States was plunged into war, one definitely new word has emerged in airline maintenance. That word is "womanpower." No longer is the role of women confined to that of hostess or ticket agent. In our current maintenance department expansion program, now nearly completed, provisions have been made for maintenance crews we expect will be 50 percent women.**

**In less time than it takes to tell it, the nation's airlines answered Uncle Sam's call with equipment they had on hand and began a new era in aviation—the era of cargo liners, supply ships, of vast freight transportation by air, and, of full scale use of women in all branches of the service. Flying** military cargo ships to the fighting fronts puts domestic airlines in a dual role, for they still are operating as carriers of priority and civilian passengers, mail and express, to every vital industrial center of the nation. Naturally, this dual load has called for expansion, particularly of maintenance facilities. These, like all other facilities of war, have to be on a production basis.

To meet this steadily growing problem of maintenance of our equipment, Western Air Lines put draftsmen and architects to work on a proposed addition to existing maintenance housing and is now completing the structure to effect isolation for the maintenance department's shops. Further,

**There are a number of jobs around maintenance shops that can be done as well or better by women than men. At Western Air Lines special facilities are being established to permit fullest utilization of women for maintenance work.**

we have set up a hiring and training program that will provide 100 mechanics during the year.

Because it is anticipated that about 50 percent of those 100 mechanics will be women, the new engine overhaul building, for example, is to be equipped with facilities that will permit their use by women. Heavy machines will be mounted on rollers and casters, special safety devices will protect these new mechanics in ways it was not necessary to afford protection before, and new rules have been adopted, among them one requiring women mechanics to wear turbans. Counterbalancing of mobile tools will be a common practice.

Rest room facilities are being provided and particular attention has been paid to shadow-free lighting, to reduce worker tension and strain to the lower limits of women workers. Wherever possible we are profiting from the experience gained by the aircraft manufacturers, who have used women in a greater variety of mechanical jobs than any other industry with which we are familiar.

Already Western has women in its apprentice mechanics classes and some have been assigned to jobs rarely before performed in airline maintenance shops by women. One, Mrs. Mary Russell, for example, in addition to her daily classes, is doing efficient work cleaning spark plugs. Another, Mrs. Agnes Mortor, works on instruments. Still another,

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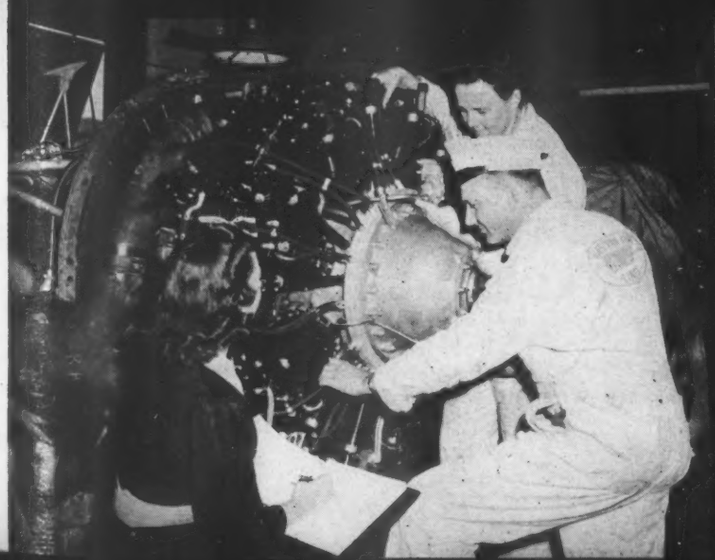
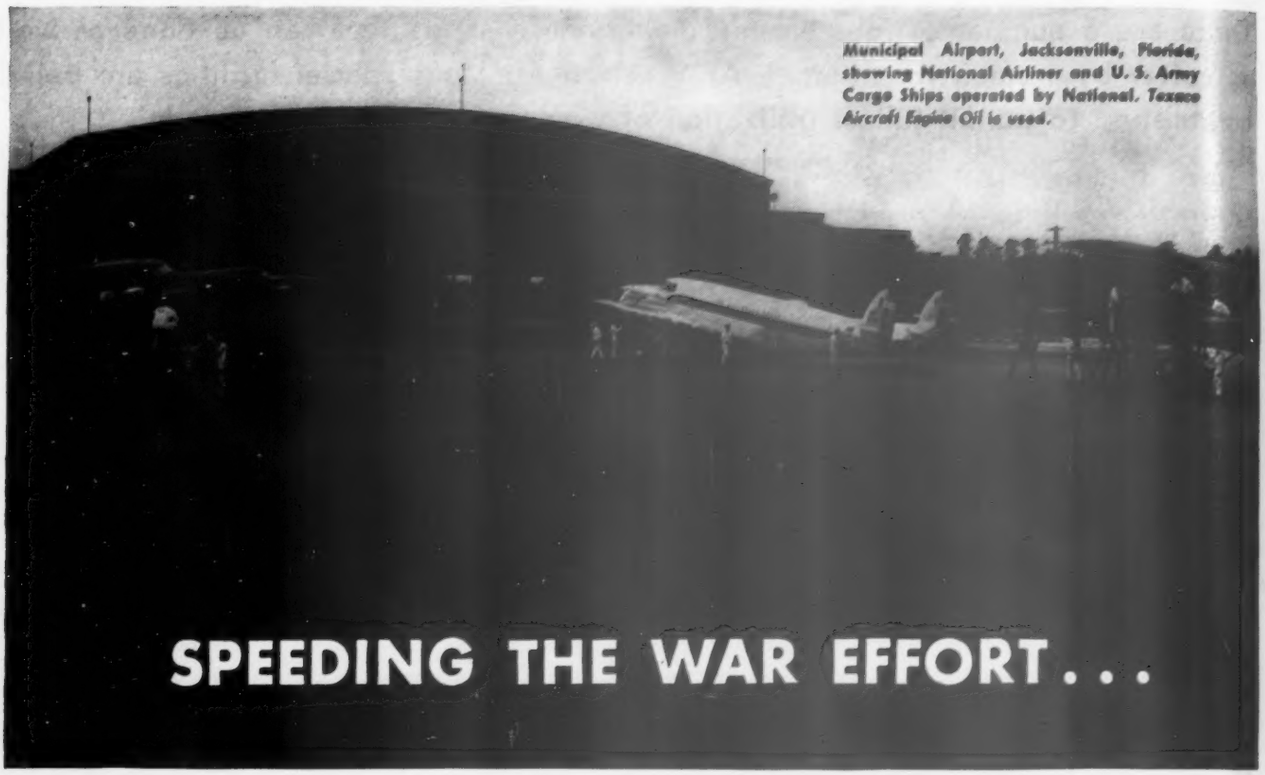
*Trainees Dorothy Sawyer (standing), and Katherine Robinson practice radio in the operations department. This department is now entirely staffed by women.*

*Mrs. Mary Russel, whose husband and five brothers are all mechanics, is in the mechanics training classes and gets accustomed to the work she will do by starting actual work cleaning spark plugs.*

*Leo Smith of the engine maintenance staff explains engine parts and functions to two women trainees. One in overalls (right) will do actual work under Smith's direction while the other takes notes. Next session the women will exchange places as note-taker and worker.*



*Mrs. Agnes Morton, wife of a Lockheed Aircraft Corp., instrument technician, is an apprentice instrument technician at Western Air Lines. During her training days she will divide her time between the classroom and the workbench.*



Municipal Airport, Jacksonville, Florida, showing National Airliner and U. S. Army Cargo Ships operated by National. Texaco Aircraft Engine Oil is used.

# SPEEDING THE WAR EFFORT . . .

## Throughout the Great Southeast

*PROVIDING 2,000,000 seat-miles a month for Army-Navy personnel, war contractors and the general public . . . Flying U. S. Army Cargo Ships some 4,500 miles a day . . . Such is National Airlines War Effort . . . bringing war plants throughout the Southeast within a few hours of each other.*

For this flying, so largely in the interests of our National Government, National Airlines uses *Texaco Aircraft Engine Oil,* a preference reflected by the entire industry, since: More revenue airline miles in the U. S. are flown with Texaco than with any other brand.

The outstanding performance that has made Texaco FIRST with the airlines has made it FIRST in the fields listed in the panel.

Texaco users enjoy many benefits that can be yours. A Texaco Aviation Engineer will gladly cooperate in the selection of Texaco Aviation Products, available at leading airports in the 48 States. Phone the nearest Texaco distributing point, or write The Texas Company, *Aviation Division,* 135 East 42nd Street, New York, N. Y.

### THEY PREFER TEXACO

★ More Diesel horsepower on streamlined trains in the U. S. is lubricated with Texaco than with all other brands combined.

★ More locomotives and cars in the U. S. are lubricated with Texaco than with any other brand.

★ More revenue airline miles in the U. S. are flown with Texaco than with any other brand.

★ More buses, more bus lines and more bus-miles are lubricated with Texaco than with any other brand.

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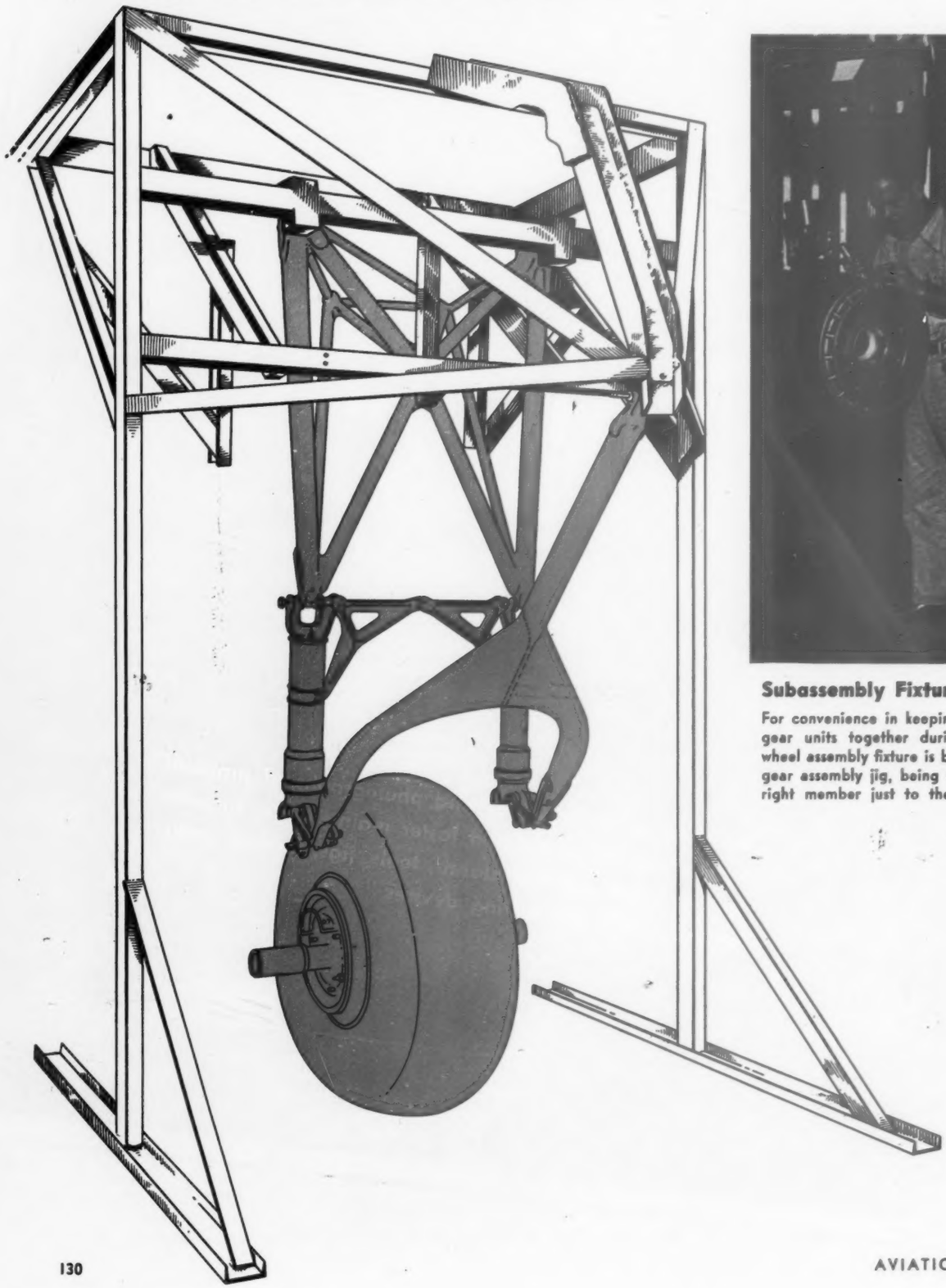
## FOR THE AVIATION INDUSTRY

TUNE IN FRED ALLEN EVERY SUNDAY NIGHT—CBS ★ HELP WIN THE WAR BY RETURNING EMPTY DRUMS PROMPTLY

AVIATION'S
MAINTENANCE
NOTEBOOK
Sketches, detail drawings and photographs of practical innovations for better and faster maintenance: includes special hoists and workstands, tools, jigs, fixtures, jacks, dollies, racks and testing devices.

## For Easier and Swifter Assembly

**This jig was built by Eastern Air Lines' maintenance department for complete assembly of Douglas DC-3 landing gear units prior to installation on planes undergoing overhaul. Use of the jig eliminates congestion around the engine nacelle, thus saving considerable time in getting planes back on the line. Of welded construction, it was built almost entirely of the type of material found "outside in the junk pile."**



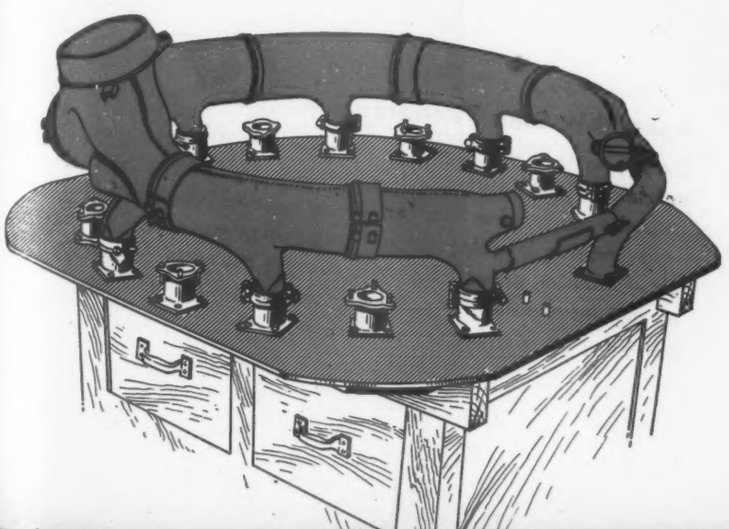
## Subassembly Fixture

**For convenience in keeping complete landing gear units together during reassembly, this wheel assembly fixture is built into the landing gear assembly jig, being attached to the upright member just to the left.**

Photo by W. F. Gerathe

## One-Man Mobile Platform

Maintenance mechanics at outlying Pan American Airways bases have found this mobile one-man ladder invaluable in quickly reaching high, inaccessible parts of the *Clippers*. The work platform, complete with guard rails, can be set at any height by means of the crank at left, placed at convenient working height. Note how all four castors can be swung into position for moving the ladder by moving the single lever seen below the crank.

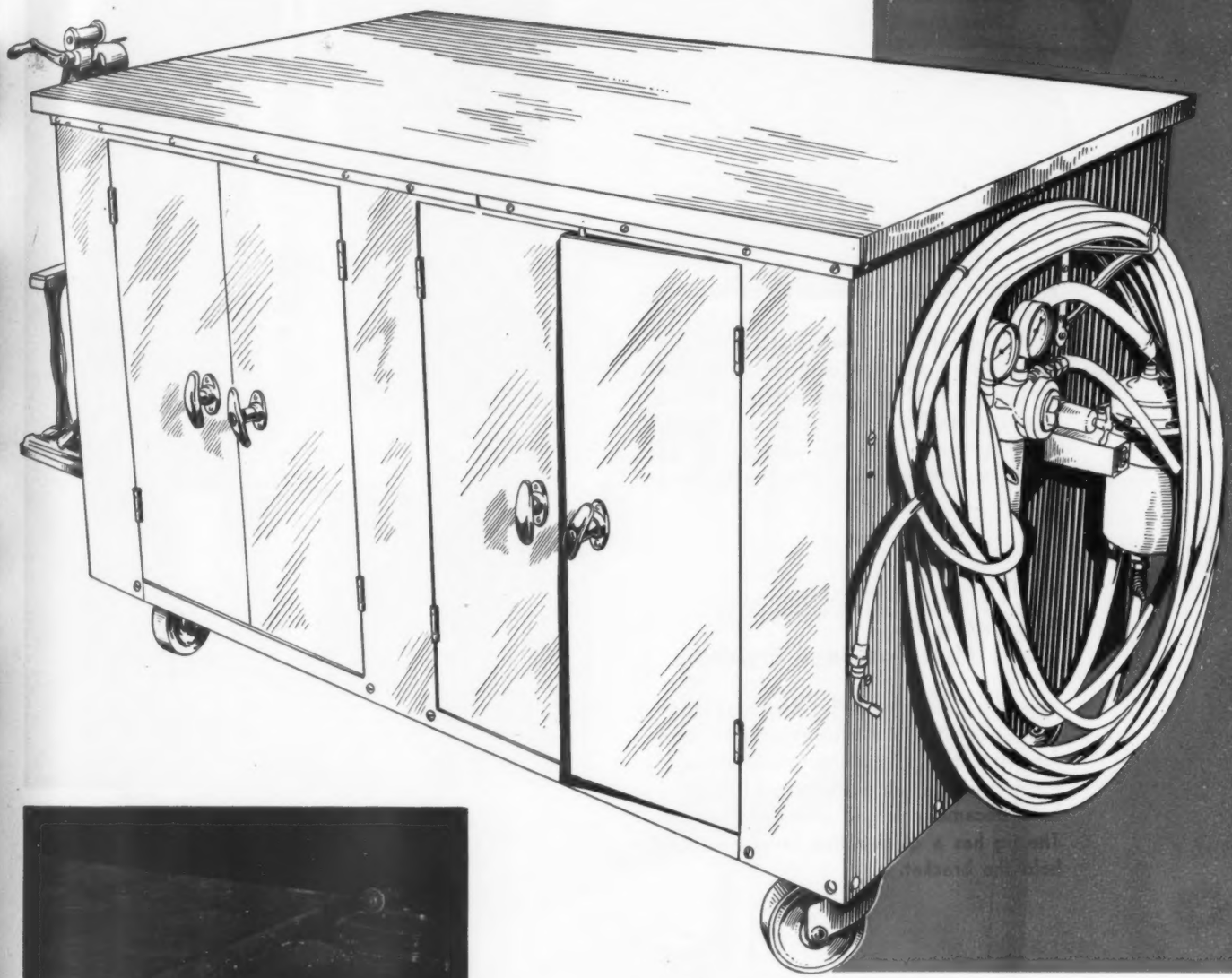


## Collector Ring Aligning Jig

This two-purpose jig was designed and built to insure accuracy and speed assembly of exhaust collector rings by the TWA maintenance department. Use of the jig makes possible the proper fitting of all sections of the collector ring before it is installed on the engine. Thus, defective sections may be replaced and properly fitted to the ring and stub stacks prior to installation. With this set-up, personnel assigned to such work can furnish completed rings to the engine build up crews, saving congestion around the engine being built up and providing standardization of the units.

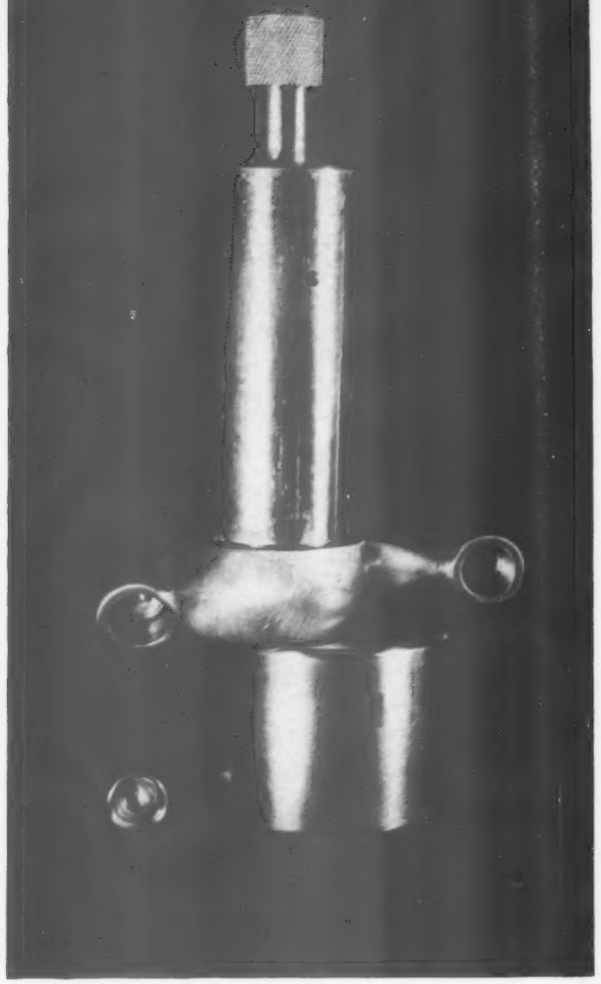
**Assembly Line Technique**

On the engine build-up line at American Airlines, "expendable" parts are stored in conveniently located bins opposite the engine line for use as needed, eliminating waste motion in going through requisition procedure at the storeroom. Broad work stand running the entire length of the line provides space for "subassembly" work with necessary parts conveniently at hand.



## Portable Paint Stand In Use at American Airlines

Complete with compressor, sprayer, masking tape rollers and cutter, this completely selfcontained paint stand can be rolled right up to the airplane to do practically any type of painting job necessary. Photo at the left shows the masking tape rolls and cutter, as well as a fire extinguisher.

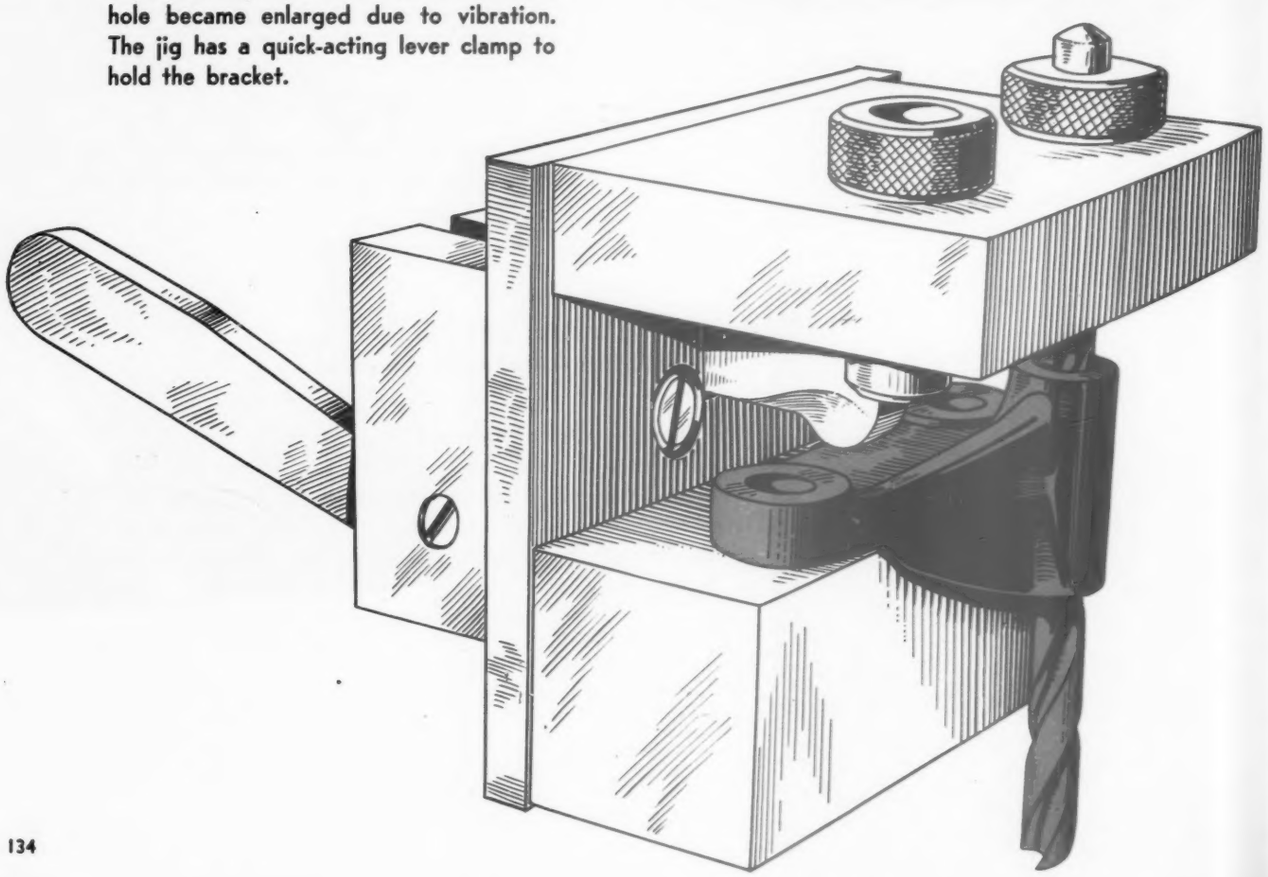


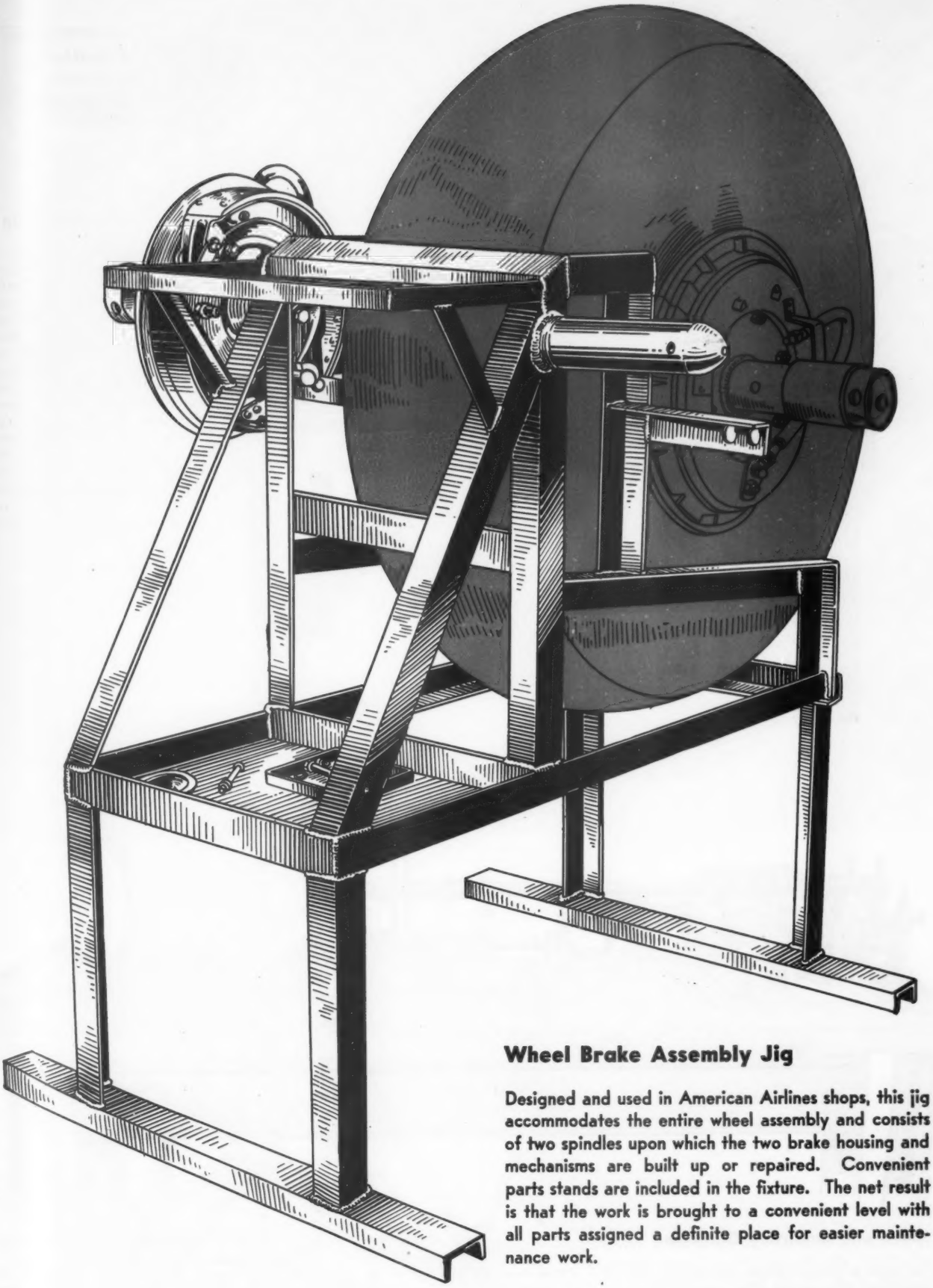
## Rocker Arm Socket Remover

Hydraulic fixture for removing rocker arm ball sockets made by Continental Air Lines personnel. The end of this device is turned to a diameter to fit the rocker arm and by applying pressure to the plunger the oil forces the ball socket out of the rocker arm.

## For Salvaging Cowl Flap Fastener Brackets

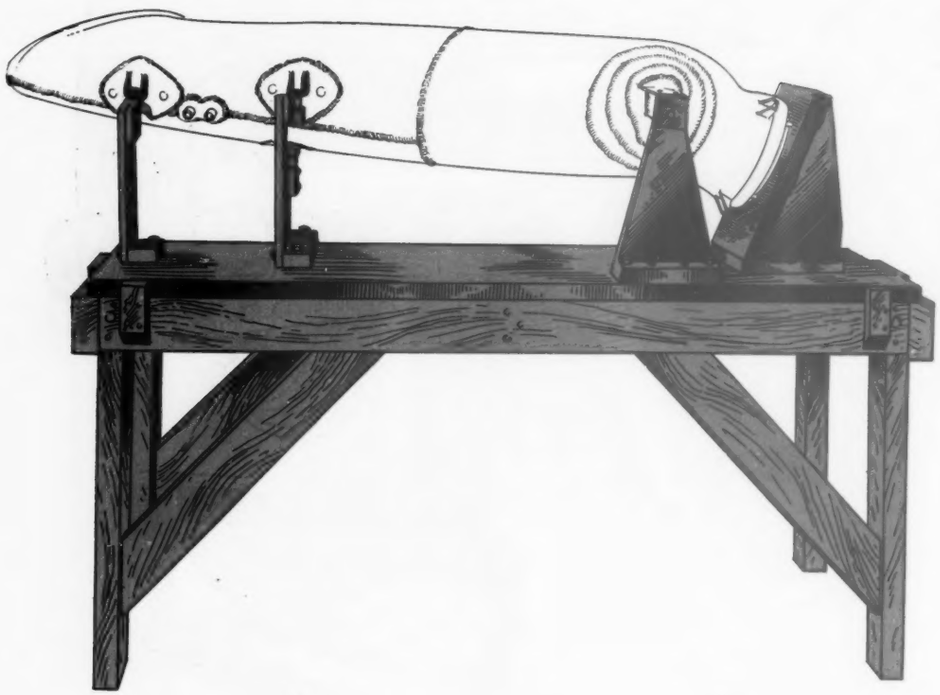
A jig for drilling cowl flap fasteners made in the Continental Air Lines machine shop for installation of bushings where formerly these bushings were discarded after the hole became enlarged due to vibration. The jig has a quick-acting lever clamp to hold the bracket.





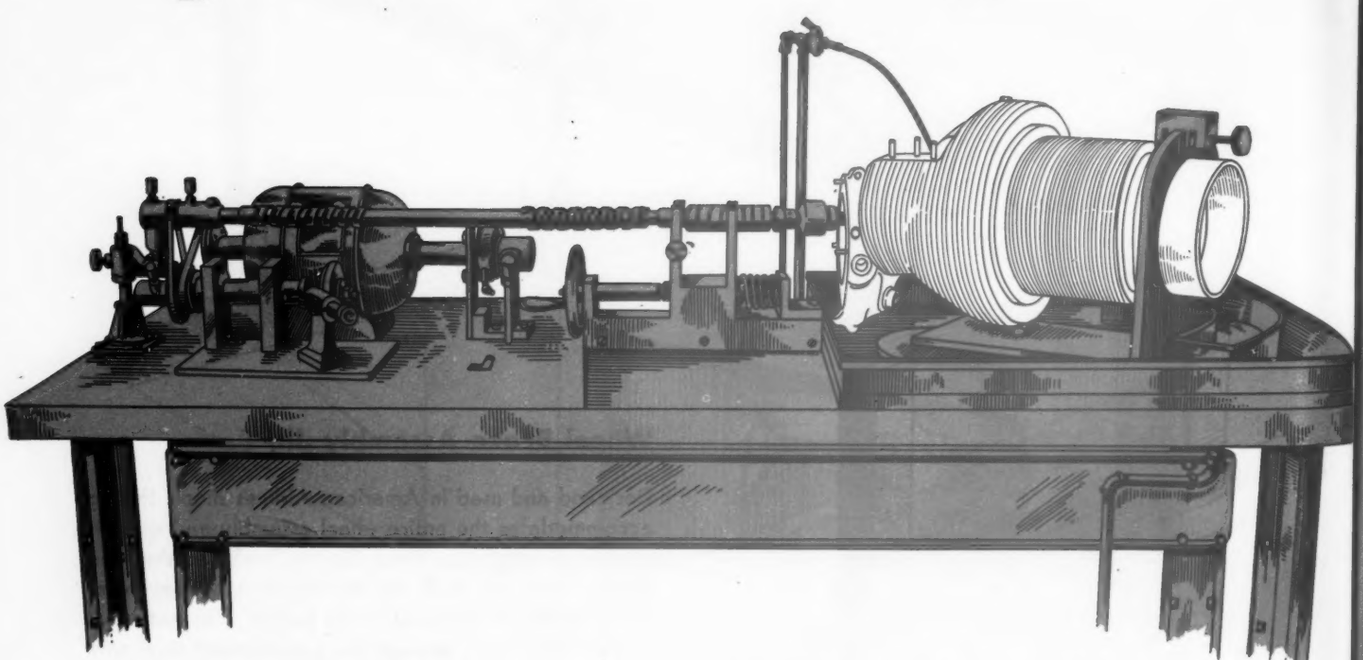
## Wheel Brake Assembly Jig

**Designed and used in American Airlines shops, this jig accommodates the entire wheel assembly and consists of two spindles upon which the two brake housing and mechanisms are built up or repaired. Convenient parts stands are included in the fixture. The net result is that the work is brought to a convenient level with all parts assigned a definite place for easier maintenance work.**



## Exhaust Pipe Repair Jig

Cracking of exhaust tail pipes at the forward attachment point due to misalignment of attachment fittings when repairs were made to the pipe has been overcome by TWA maintenance engineers by use of this jig, which they designed and built. Note that all materials used in the jig are very heavy; this was found necessary to prevent distortion of the pipe during the cooling process after the pipe has been repaired or the fittings aligned. While in this case a stand was built especially for the jig, it can be used on any bench and stored to conserve space between jobs.



## Speed and Accuracy Combined

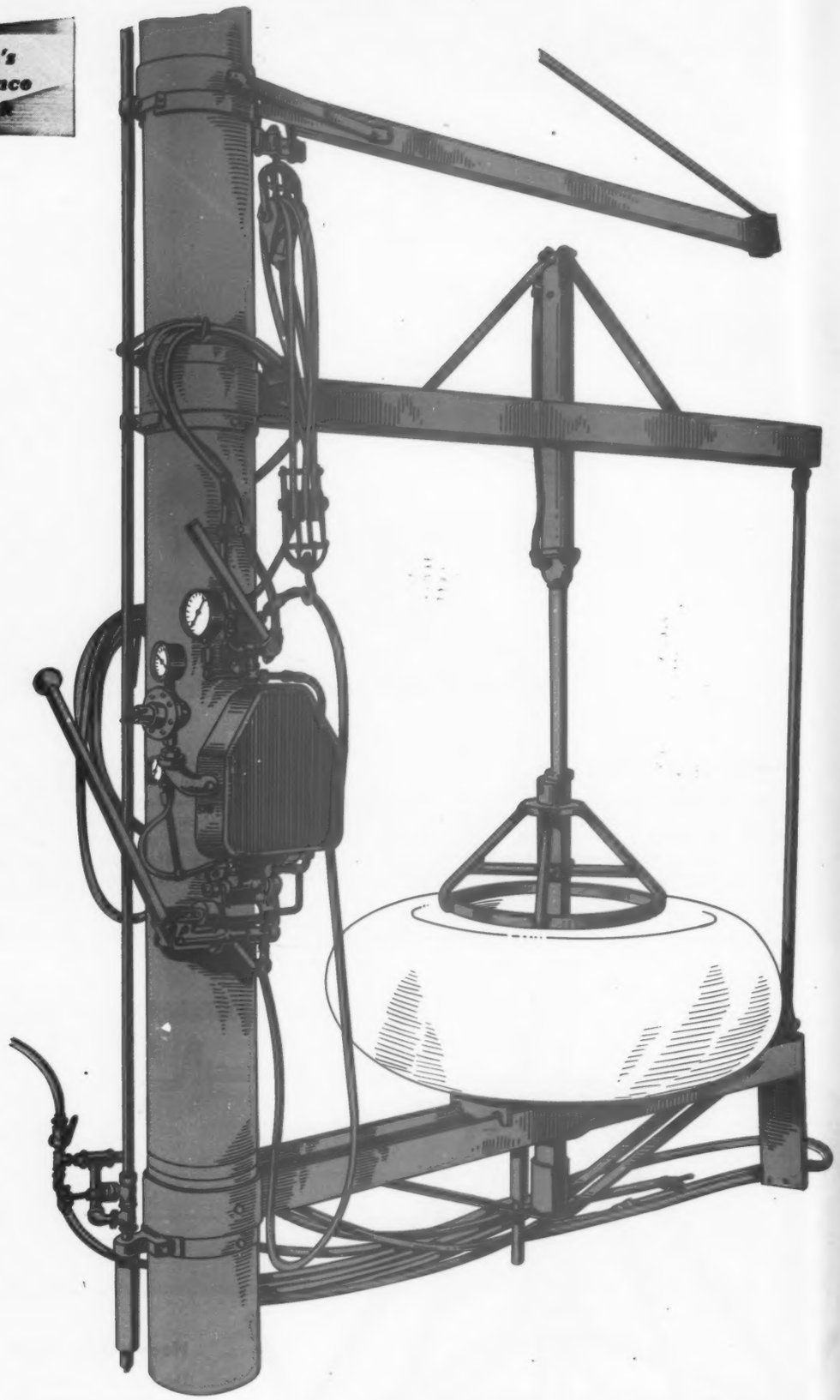
This valve grinding machine was built by the TWA engine overhaul department after several other types had been tried and found wanting. It grinds either the exhaust or intake valve in 15 min., its 1-hp. electric motor driving the grinding wheel at 4,000 rpm. The shaft which moves the grinding wheel in and out is provided with micrometer adjustment for close adjustment of the wheel. The machine is also equipped with a stationary wheel dressing mechanism, seen just in front of the motor. A constant flow of kerosene is pumped to the grinding wheel through the line shown just to the left of the cylinder. The fluid, which drains through the pan shown just below the right end of the cylinder, is thoroughly filtered before being fed again to the wheel.

## Aileron Control Stop

This unusual device was designed by the TWA maintenance department to prevent aileron control surfaces of DC-3 aircraft from whipping when subjected to extreme gusts of wind on the ground. The important feature of this control stop is to eliminate any damage that might be encountered should the landing flaps be lowered with the control board installed. Note that the lower inboard portion of the stop is cut away to provide lowering of the flaps without damage. The attaching clip that engages the trailing edge of the wing when the board is installed is attached to the standard ball weight in such a manner that the clip will be released allowing the board to be pulled off automatically, should the airplane be moved before the board is taken off by ground personnel.

## Heavy Duty Jack

The jack, built by Pan American maintenance engineers, was designed especially for use with the Boeing 307 *Stratoliners*. The wheels can be lifted by moving the two handles seen at either side and the load carried directly to the ground through the shoe at the bottom of the hydraulic column. The exceptionally wide base eliminated the need for slings to steady the plane while being raised on the jack.



## Mechanical Tire Iron

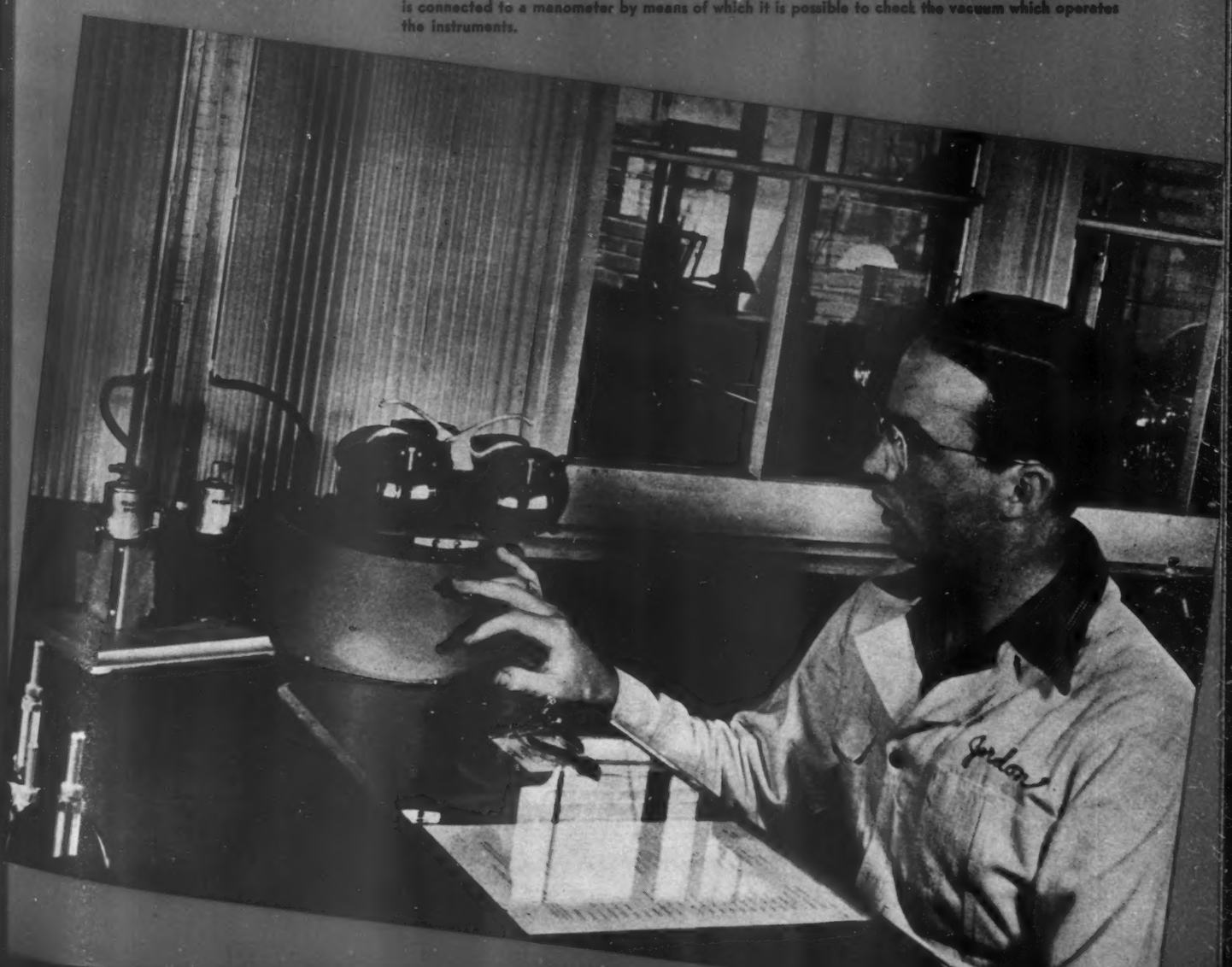
To overcome the problem—and a big one it was—of separating tires from wheel flanges for large aircraft, the TWA maintenance department designed and built this tire mounting and dismounting jig and assembly which has been used for both DC-2 and DC-3 planes. In operation, the tire, wheel and axle are hoisted by the end of the axle —with the block and tackle seen at left—and the complete assembly is installed in the dismounting rack. The actual separation of tire and flange is accomplished by hydraulic pressure—built up by the hand pump shown attached to the main column at left—which gives the power necessary to get the bead over the flange.

## Engine Mount Alignment Jig

Production line standards of precision can be maintained with this engine mount alignment jig which was set up by Eastern Air Lines' maintenance department. The central vertical column, of heavy tubular material, is bolted to the heavy metal base which, to insure rigidity, is mounted on steel I-beams. The ring aligning plate at top is also of heavy metal to maintain accuracy.

## Test Stand Simulates Flight Conditions

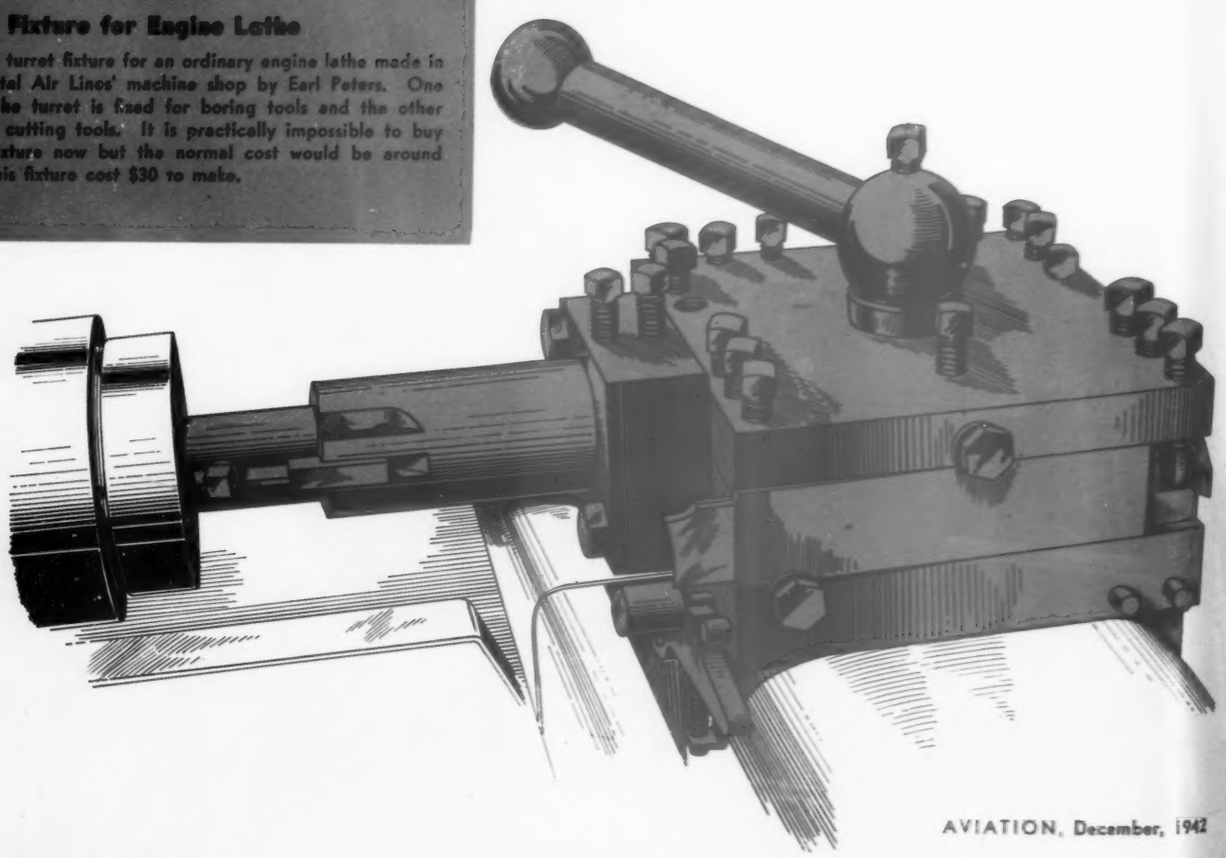
Designed and developed by United Air Lines, this test stand permits accurate checking of turn indicators under simulated flight conditions. A saddle holding the indicators is turned by a synchronous motor at the rate of 180 deg. per min.—United's standard rate of turn. A friction clutch is provided for convenience in checking instruments for general operation. The device is connected to a manometer by means of which it is possible to check the vacuum which operates the instruments.



Aviation's Maintenance Notebook

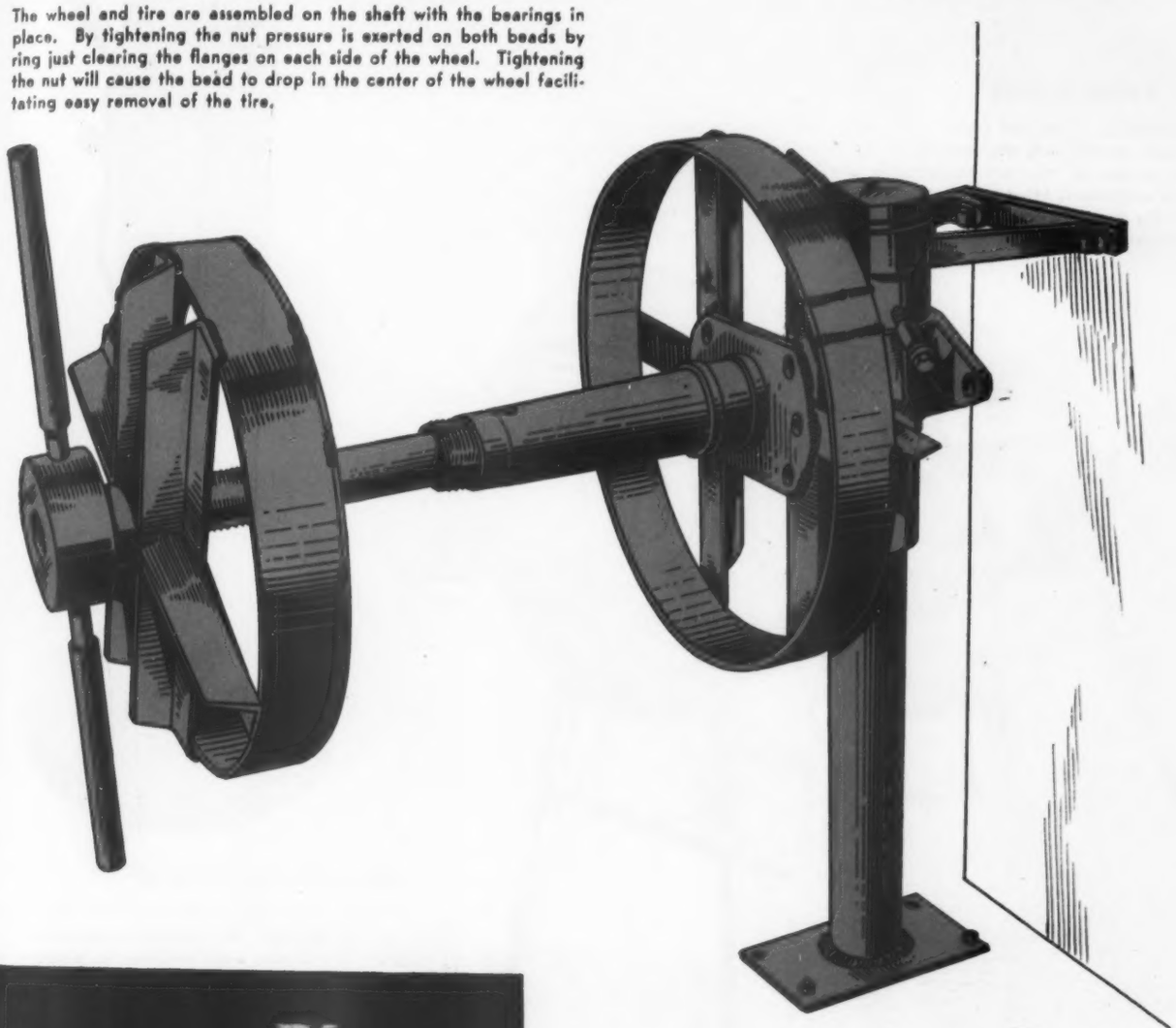
## Turret Fixture for Engine Lathe

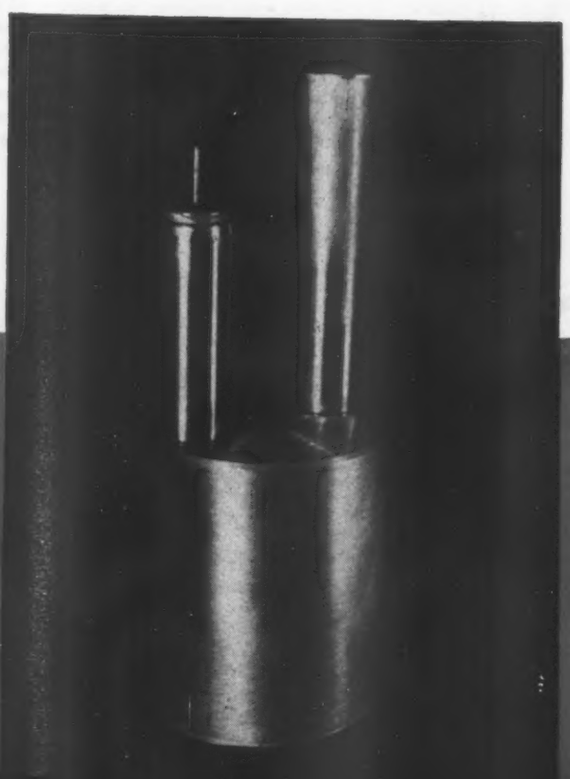
A square turret fixture for an ordinary engine lathe made in Continental Air Lines' machine shop by Earl Peters. One side of the turret is fixed for boring tools and the other sides for cutting tools. It is practically impossible to buy such a fixture now but the normal cost would be around $185. This fixture cost $30 to make.



## Tire Removing Fixture at Continental Air Lines

The wheel and tire are assembled on the shaft with the bearings in place. By tightening the nut pressure is exerted on both beads by ring just clearing the flanges on each side of the wheel. Tightening the nut will cause the bead to drop in the center of the wheel facilitating easy removal of the tire.



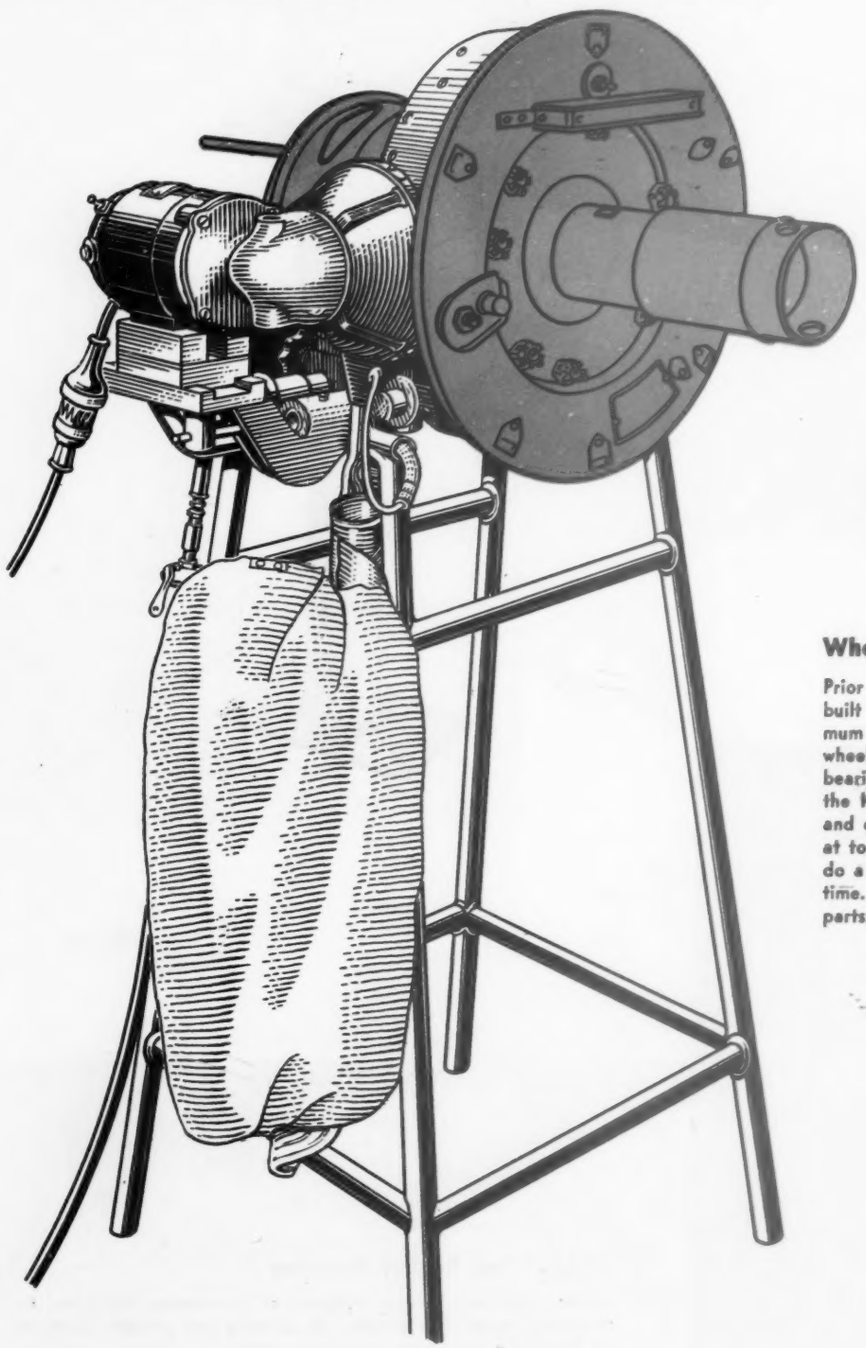


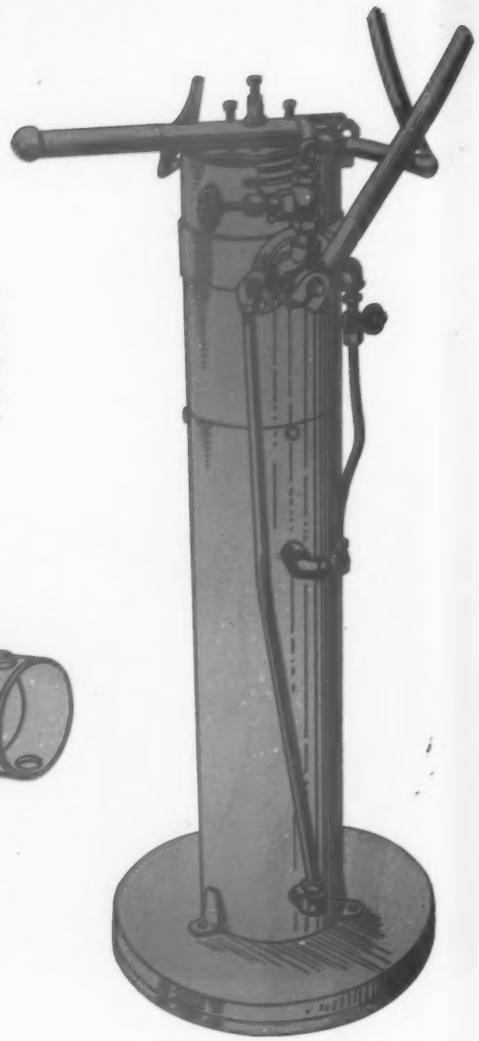
## Tappet Ball Socket Remover

Another hydraulic fixture designed at Continental Air Lines for removing tappet ball sockets. By pressing one plunger down the oil forces the ball socket out of the tappet.

## For Better Braking

This machine, assembled from a wide variety of "salvage" parts—including a household vacuum cleaner—was designed by the TWA maintenance department for sanding brake shoe surfaces so they will be perfectly round after assembly as a unit. Thus, when the brake assembly is fitted to the ground brake drum, complete alignment may be obtained and the proper clearance adjustments made with little difficulty. Shop cleanliness is enhanced by use of the vacuum cleaner collector-bag shown below the sanding wheel.





## Wheel Bearing Greaser

Prior to installation of this machine, designed and built in the TWA maintenance department, a minimum of 10 min. were required to properly work wheel bearing grease in around each roller of the bearing race. The bearing is locked in place under the horizontal handle seen at top of the machine and compressed air, turned on by the handle seen at top right, forces the grease into the bearing to do a more thorough job at considerable saving of time. The machine was built largely of "salvage" parts.

**Turn and Bank Test Stand**

A reversible synchronous motor turning 1,000 rpm. geared down 3,600:1, driving a turntable and transfer head comprise the main units of this test stand. On the turntable is mounted the suction regulator valve, manometer and the turn and bank indicator. The vacuum source is brought through the base of the test stand and carried up to the transfer head which distributes vacuum to the turntable throughout a 360 deg. turn. The use of this machine eliminates the human element in timing of turns with a stop watch. As TWA uses single width 3 deg. per second rate of turn all that is necessary to check the instrument on the stand is to set the vacuum on the turn instrument to 2 in. HG and operate either in left or right turns and calibrate the instrument mechanism until desired one needle width indication is obtained.

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# MANUFACTURING
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PRODUCTION · DESIGN · RESEARCH · ENGINEERING

# DESIGN CONSIDERATIONS FOR PLYWOOD STRUCTURES . . . II

**The second in a series of articles containing fundamental information on plywood airplane design discusses limitations imposed by fabrication processes and explores new basic design features made possible by use of plywood as an aircraft material.**

By **L. J. MARHOEFER**, *Chief Engineer, Vidal Research Corporation*

A CLEAR UNDERSTANDING of the molding process is essential if a proper and economic design is to be effected. Prime consideration must be given to the construction of the article, its molding and subsequent removal from the form. In effect this consideration is really only another step in the list of compromises required of any design.

Due to the large number of articles published recently on fluid pressure molding, a brief summary of the salient points should suffice. Fluid pressure is essentially a clamping device having the distinctive feature of applying equal pressure perpendicular to the surface of any enclosed body. This pressure is harnessed to perform useful work by establishing a fluid tight form of any desired shape on one side of the raw stock and a fluid tight membrane on the other. If the fluid is enclosed in a pressure resistant vessel and the pressure increased, the membrane and fluid tight form will be forced together and since the raw stock is already trapped between the two it also will be clamped against the form. (Fig. 1.).

Setting of the bonding agents by means of heat, aging or chemical reagents is an obvious step. The result is a piece closely conforming to the shape of the form and completely bonded. The designer's vital concern is that the piece be of simple construction and removable from the form after it has been molded. Simplicity is an ideal of any construction and requires no general discussion. Removal from the form is more readily understood if a piece is considered to be similar to a casting for which no core blocks can be constructed.

### Moldable Piece Details

The requirement of no "back-draft," usually encountered in casting design, is present with somewhat enlarged tolerance. Most articles after molding have sufficient flexibility to permit "springing" them open to an appreciable degree and then sliding them off the form. The amount of spring varies with the size piece and stiffening members molded into it. Examples of the amount of "spring" are shown in Figs. 2 and 3. Fig. 2 is representative of a two-place commercial fuselage in which a $\frac{1}{4}$-in. strip was molded in a "locking" position. No great difficulty was experienced in springing this fuselage out from the bottom and top sufficiently to free the $\frac{1}{4}$-in. strip and lift the piece from the form. Fig. 3 is a wing shell in which a $\frac{3}{8}$-in. lock was freed by "springing" the piece and sliding the form out of the trailing edge.

No precise rules may be laid down for the amount of spring with the exception of computed stress values based on required deflection in the shell when opened the requisite amount. Such computations would obviously be tedious and current practice has been to rely on judgment and trial.

Collapsible forms are only a partial answer to this problem. They have been constructed for many pieces and used successfully. The principal deterrents are the added expense in the original tool cost and the difficulty of realignment with sufficient accuracy in production. Their use is advisable only in extreme cases since most articles can be adjusted to permit removal of the forms.

The choice between male and female mold reduces primarily to economic factors involved in the cost and difficulty of finishing the molded article balanced against the cost of installing the stiffening members after molding. The salient points favoring a reinforced structure constructed on a male mold are the elimination of the highly skilled joining operations required to install stiffeners and frames after molding and the assurance that the "molded-in" reinforcing is properly bonded regardless of the skill of the fabricator. The inherent excellence of the bond between the shell and reinforcing members is not clearly appreciated by many designers due, primarily, to their lack of familiarity with the resulting product and the skill required to obtain an equal "built-in" bond.

### Fundamental Reason for Integral Reinforcing

The reason that these "molded-in" reinforcing members are soundly bonded is based on a fundamental requirement of any glue joint. This requirement is "there must be intimate contact between the bonding surfaces." This requirement is the reason behind the skilled craftsmen's care in preparing scarf joints and then applying extreme clamp pressures. The first operation eliminates all inherent irregularities and renders the two surfaces substantially coplanar. The second serves to overcome both the lack of skill exercised in the first operation and to prevent the warping and grain lift due to glue moisture from defeating a properly prepared joint. Inherent in the above are two operations practically impossible to control in a production set-up. The present acceptance of the "built-in" bond is a tribute to the conscience and care of the average workman and the ingenuity of the designer in locating such joints where only low stress values are needed. The isolated structural failures in service should be a clear warning that the system requires re-examination.

The fluid pressure molding operation combined with heat contains all the necessary elements required to achieve the fundamental intimate contact between the surfaces to be joined. Most of us are familiar with the fact that wood when heated may be formed into shapes not practicable when they are

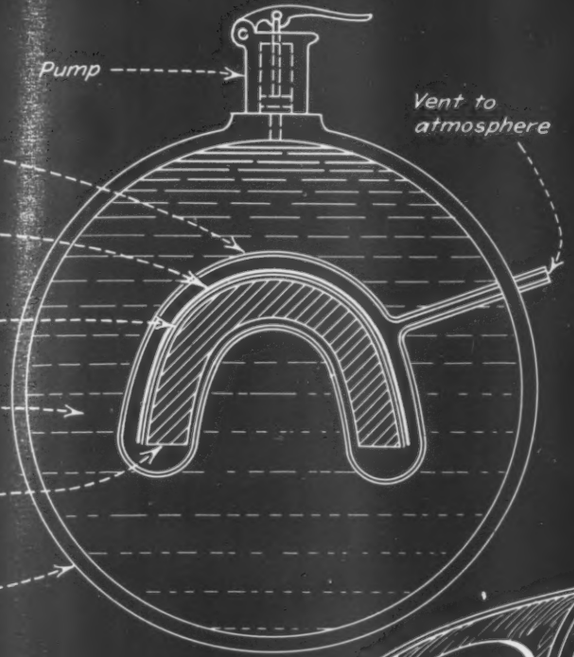



FIG. 1. Elementary fluid pressure clamp. As pressure is increased on fluid, the membrane will collapse tightly against pre-wrapped stock, clamping it firmly to the form contour.

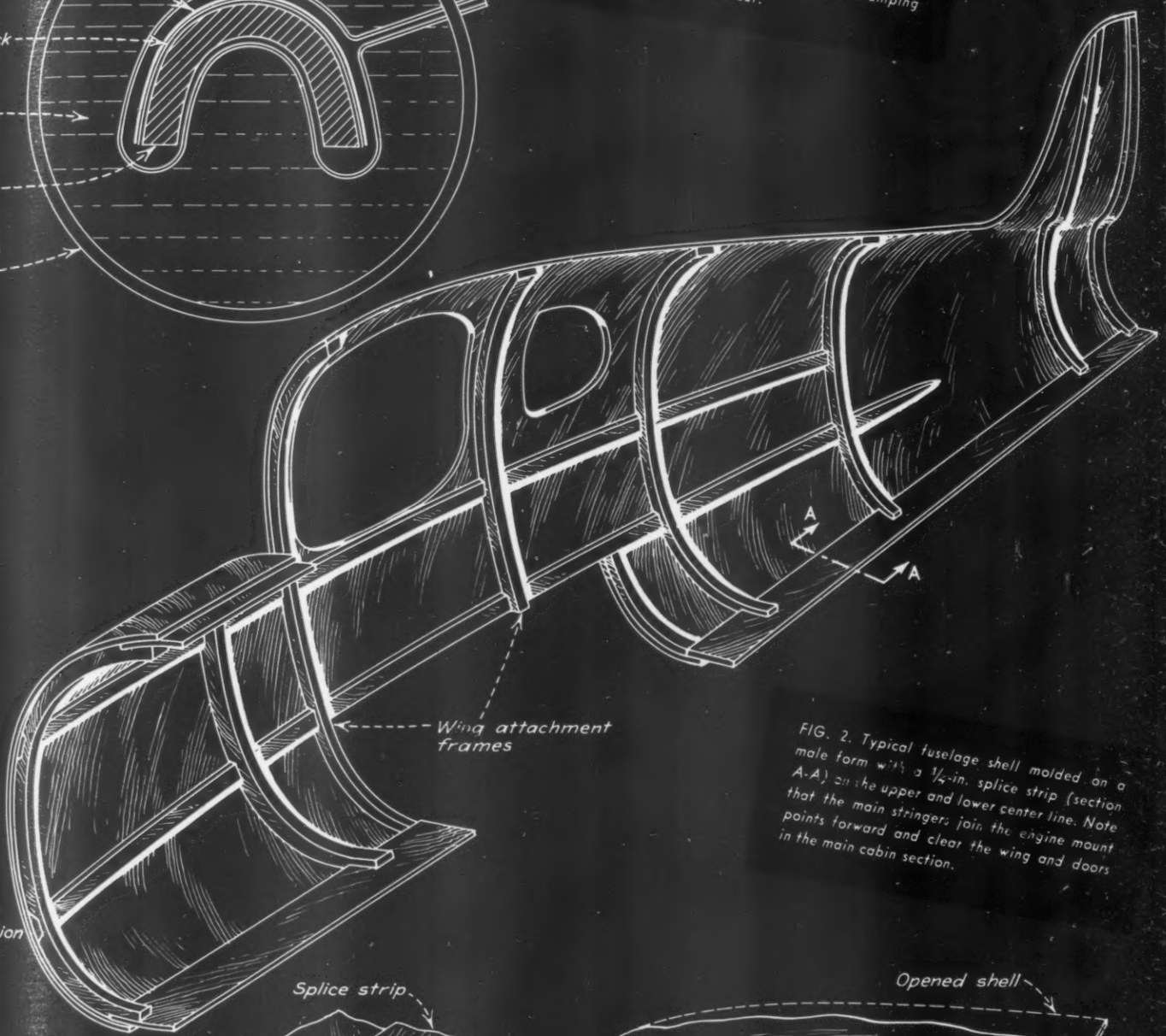



FIG. 2. Typical fuselage shell molded on a male form with a ¼-in. splice strip (section A-A) on the upper and lower center line. Note that the main stringers join the engine mount points forward and clear the wing and doors in the main cabin section.

Splice Detail A–A

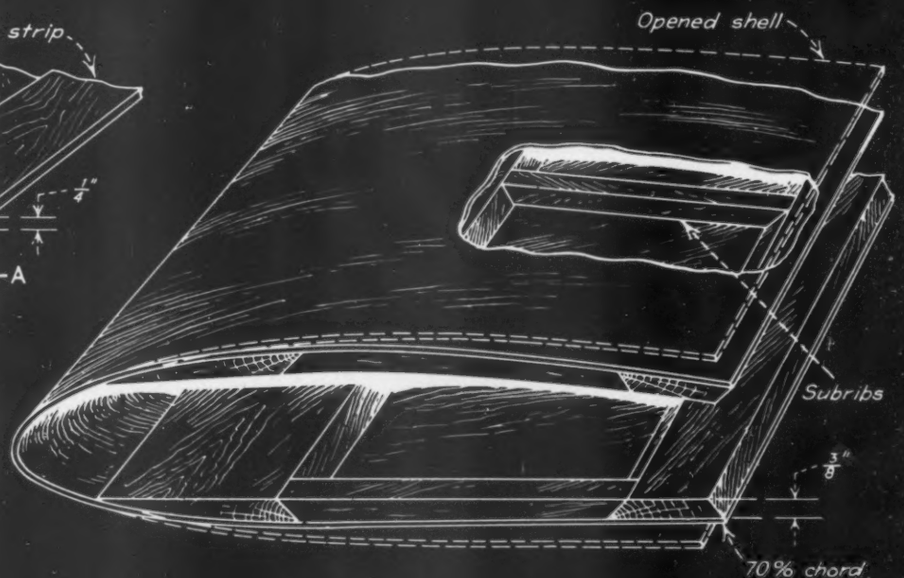
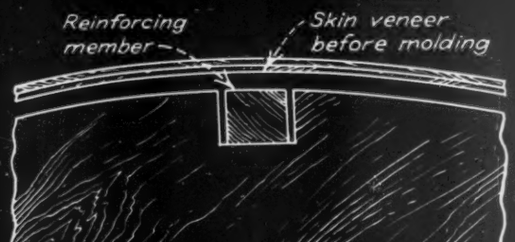



FIG. 3. Molded wing shell showing how the shell is sprung open sufficiently to free the ⅜-in. "lock," top and bottom, from the form.



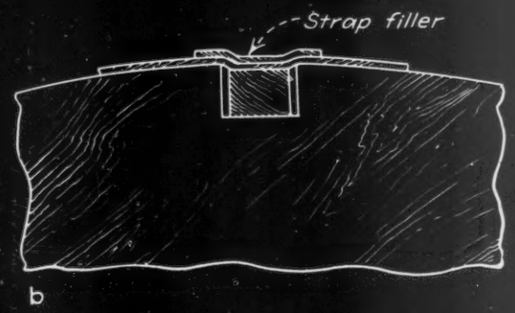




FIG. 4. Showing how the skin veneers are molded and joined with stringers. Fig. 4a is a typical section through the form, reinforcing, and skin before molding. Fig. 4b is the same section after molding showing the position of the additional veneer "filler" over the reinforcing joining area.

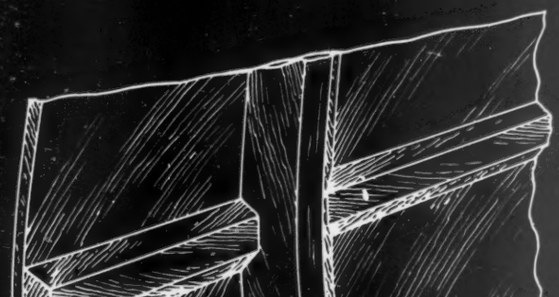


FIG. 5. Details of reinforcing required for female form employed in molding plywood.

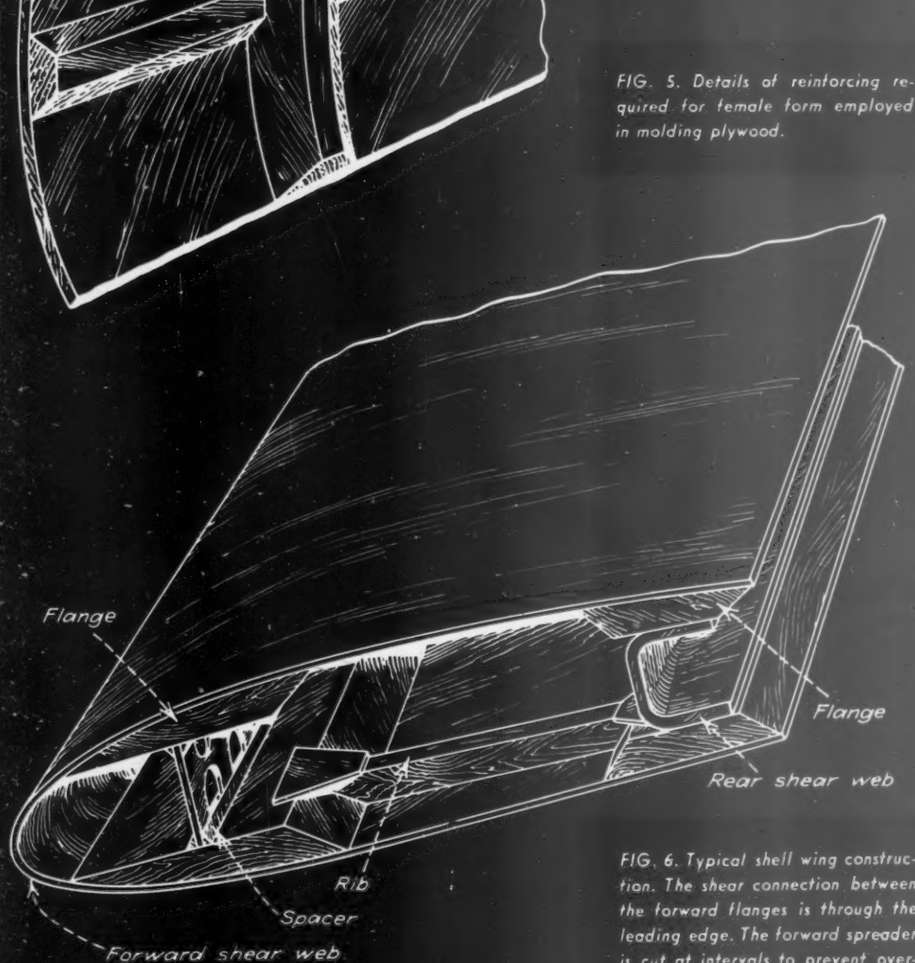



FIG. 6. Typical shell wing construction. The shear connection between the forward flanges is through the leading edge. The forward spreader is cut at intervals to prevent overloading the joint between spreader and flange.

cold. Furthermore these shapes are substantially retained after the wood has cooled. Past practice has made use of this in the forming of boat ribs, automobile frames and similar operations. This forming effect is accentuated when applied to veneers and was driven home by the annoying ability of the veneer to outline perfectly even a 0.01 shim accidentally left between the veneer layers.

It was apparent that the veneers under the heat and pressures being used would deform until they broke or rested against a solid foundation. The early attempts to install reinforcing structures during the molding were approached with extreme caution and with the assumption that a poor grade of bond would result. For this reason the bonded areas were made large. Encouraged by the success of these pieces the bonding area has been continually reduced and the current limitations on bonding surface are principally for shop handling before the article is assembled.

## Surface Irregularities

A more detailed discussion of the bonding of reinforcements into a structure is felt to be warranted. Fundamentally it appeared rational to assume that since an unlimited number of sound glue joints might be formed between layers of veneer that one more glue line should be feasible to which a stringer or frame was attached. The first articles so constructed were indeed distressing. Every frame and stringer was sharply outlined as a lump or depression in the shell. This was at first blamed on insufficient care in cutting grooves in the forms and inaccuracy in the size of the reinforcing parts. In spite of the most exhaustive efforts perfect articles were not obtained. This very irregularity in the surface, however, was primary evidence of the fact that the skin veneer under heat and pressure would deform until it was in complete and intimate contact with a solid foundation whether that foundation was the form or a reinforcing member. The inability to cut the reinforcing members so that they were invisible on the finished article was determined as due to the different shrinkage rates under heat and pressure and was a further unrealized asset. During the molding cycle the heat tends to bring all parts of the structure to the same moisture content.

The achievement of a smooth surface was not complicated as to solution but somewhat delayed in achievement. One obvious method was the use of a female form with the pressure dam against the reinforcing parts. Several articles were successfully so constructed and achieved

the desired result of giving a fine smooth skin. Special care was necessary in designing the reinforcement in order to prevent bag failure. (Fig. 5.) The most serious drawbacks were the difficulty encountered in assuring proper locations for the reinforcements and the proper placing of the veneer on the female form.

The advantage of the male form is quite clearly and primarily the fact that it may be used as a jig to hold the reinforcing members in their proper position and thereby assure accurate duplication of articles. Its disadvantage in leaving the reinforcing members outlined on the exterior surface was overcome by a very simple expedient. Noting that the actual shrinkage in a number was small and that they never swelled, the reinforcing pieces were cut to fit flush with the form or approximately 1/64-in. small assuring that the surface irregularity would be a depression. After installing the part in its groove the skin veneers were applied and finally an extra strip of veneer was applied to the outside as a local additional layer over the reinforcing member. (Figs. 4a and 4b.) After molding this bond provided an excellent and thoroughly bonded "filler" which could be shaved flush without injury to the structure or skin. Obviously the proper thickness of strip is the sum of the undersize plus the shrinkage.

There is an apparent tendency at this time to return to early plywood aircraft as a guide in deciding the amount, size and location of reinforcing members. While these early aircraft were admirable and serviceable articles the reinforcing arrangement was quite often determined by other than structural reasons. Primarily these craft were designed for construction of flat plywood which was soaked or steamed and then forced into the desired shape. In order that this shape be retained during the life of the article it was necessary that the framing be of sufficient substance and rigidity to resist the tendency of the plywood to return to its original flat condition. A primary consideration therefore was the jig-like rigidity necessary in the internal structure. Additional intercostal stringers were then installed to comply with the dimensional limitations of the plywood then obtainable. Credit is indeed due to these designers for their ability to construct aircraft of high performance with the essentials of a jig built into them.

Molded shells have the very distinct advantage over flat bent plywood of retaining their molded shape without the aid of structural reinforcement. Additionally the "stock size" limitation is removed, thus eliminating the need for members whose primary purpose is the provision of a skin splice backing. In designing molded articles the only reinforcing necessary is entirely structural. Frames are necessary to distribute major structural loads into the shell, to reduce the column length of stringers and to prevent skin buckles. Load supporting frames should be designed as redundant rings in a manner quite similar to a metal frame. The proper width of frame is proportioned to maintain the stress on the glue joint between the skin and the frame below the maximum allowable value. The depth of the frame may be varied to correspond to the bending stresses along the frame axis.

The decision to use stringers or increase the shell thickness must be governed by comparative weight studies and relative cost estimates. In order to assist the cost estimates it might be noted that the material, labor and overhead cost of veneer in a molded aircraft structure is approximately 11c. per sq. ft. or, with usual veneer thickness and weight about $1 per lb. On an equivalent labor and material market stringers of solid spruce may be estimated on the basis of 43c. per lb. Economically it usually is better to reinforce a shell rather than thicken it. Most comparative weight estimates on specific structures have also indicated the desirability of using stringer which may be tapered without unreasonable cost but an appreciable weight saving. It should be noted that the above estimates are comparative only and not indicative of the actual cost of finished articles. The number of variables governing the cost of any particular article is infinite.

## Structural Arrangement

Basically any aircraft structure, regardless of material, is a system of bending and shear resistant parts joined into a structural entity. Sound design requires the quantitative evaluation of the external loads and the careful determination of the resultant shears, moments and torsions occurring at critical points. There is a clear line of demarcation at this point where consideration must be given to the provision of a well defined and continous force and shear flow path. Provision of these paths would be simple if the structural arrangement were the primary consideration. Unfortunately, the structure must be subordinated to other requirements and the clear and obvious structural paths are lost. Door cut-outs, wheel wells, access holes, and disassembly joints then exercise substantial control over the structural arrangement. Choice of stringer and frame location then becomes a matter of available space as often as a question of expediency of structural economy. In a wing for example, the space left in the center section after wheels, gear, etc., have been retracted is then turned over to the structuralist with practically complete freedom to use all of it.

This freely given space seems to consist usually of a hole 2-in. wide by the depth of the wing. The headaches inherent in hanging a 40-ft. wing span on this undoubtedly accounts for the sometimes sour disposition and appearance of the structures group. The forces outboard must somehow flow through this space and hence the material must aim at this space from the wing tip. The influence on the arrangement of material outboard is profound and is the reason for many otherwise unaccountable wing structures.

Where sufficient space is available through the center section it is possible to take full advantage of the low density of molded plywood and approach the ideal of a completely skin stressed wing. It has been possible to construct good wings on this basis with ribs at concentrated load points only and without the use of leading edge ribs or a forward shear web. (Fig. 6.) Loadings on such wings have been successfully carried as high as 540 psf. average with the usual airfoil chord distribution. Despite the almost complete absence of internal structure in a particular wing of this arrangement the distortion was extremely small and the spanwise deflection and twist entirely normal during static tests.

The guiding principle in constructing such a wing is the provision of sufficient flange material to carry the bending moments and sufficient web material between the flanges to transmit the shears. This flange material is located as far as practicable from the neutral axis and hence becomes relatively thin. Additional material to carry the increased bending moments towards the root of the wing is supplied by increasing the flange width and permitting the flange thickness to remain constant. The shear may be carried through the leading edge skin which will then be of sufficient rigidity to prevent buckling without the assistance of nose ribs. The ability to carry the loads without buckling is inherently present in most low density webs due to the greater thickness of material for a given strength and weight.

Location of stringers in a fuselage is influenced by engine mount attachments and wing locations. In general it is preferable to use a small number of large stringers. The larger stringers have larger radii of gyration and permit greater spacing between frames. The resulting larger areas of unsupported

(*Turn to page* 315)

# Design and Installation Factors For Aircraft Hydraulic Accumulator Systems

**Various types are analyzed in relation to ease and speed of maintenance, a consideration which must be included in both construction and location.**

By EDWARD M. GREER,* *Aircraft Hydraulic Engineer*

ALTHOUGH A NEWCOMER in aircraft applications, hydraulic accumulators have been used extensively in stationary hydraulic systems from almost the earliest days of hydraulic actuation. Due to the far reaching use of hydraulic equipment in contemporary military aircraft, hydraulic accumulators have been developed to meet the increasing need for an emergency source of fluid power and to speed hydraulic action.

Specifically, an accumulator is a fluid pressure storage chamber and can be likened to a storage battery in electric circuits. It is a means of storing energy to be called upon as a source of power when the regular means of creating the necessary power, such as the generator in the electrical system and the pumps in the hydraulic system, are rendered inoperative or lack the capacity to do a particular job when called upon. In either case the potential energy stored in the unit can be called on automatically to operate the system whenever required.

The size of the accumulator depends upon the amount of stored fluid necessary to meet specific requirements set up by the design of the particular airplane in which the accumulator is employed. This is governed by any one or all of four elements as follows:

1. Pressure regulation—In hydraulic systems which employ constant displacement pumps, a pressure regulating valve is used to regulate the system pressure at a predetermined operating pressure of the particular hydraulic system. In most American airplanes this pressure is set at 1,000 psi and the regulator is set so that at this pressure the volume of oil displaced by the pump is bypassed into the return line leading to the reservoir at no pressure, while the operating pressure is maintained in the system beyond the regulator. This is called "unloading." When the pressure in the system drops due to leakage or actuation of one of the units and reaches a predetermined pressure (in this case 800 psi.), the regulator valve automatically closes the bypass into the reservoir and feeds the flow into the system until the 1,000 psi. pressure limit is again reached. This is called "loading." It may be of interest to state here that although current systems are operating at pressures between 1,000 and 800 psi., the majority of new designs are operating between 1,500 and 1,350 psi.

Due to internal leakage of the unloader or regulator valve, plus internal leakage in the valves and actuating system, the regulator valve tends to

* The author wishes to acknowledge his appreciation to Miss Alice P. Zucker for her research work on the material which made up this paper and to thank her for her contribution to this article.

load and unload very rapidly. In some cases it operates as frequently as every second. This results in shocks and vibrations which could tear lines from their fittings and do great damage to the system.

To compensate for this leakage, an accumulator is incorporated in the system as near to the pressure port of the regulator valve as possible, and of sufficient capacity to widen out the unloading periods of the regulator to at least ½ hr. and absorb any hammer that might occur in the automatic action of the valve. In general, the smallest commercial aircraft accumulator size of 69 cu.in. is more than sufficient to do this work.

2. Auxiliary to pumps—In most military applications, actuation such as landing gear retraction, dive flap operation or gun charging must be completed in a minimum of time. It may be beyond the capacity of the pump to supply a sufficient quantity of fluid under pressure to the actuating cylinders to do the job in the time limit allowed. Here the system accumulator is called upon to supply the extra push required. Depending upon the size of the airplane and the services which the hydraulic system is required to fill, either the 220- or 515-cu.in. commercial size can be used in place of the 69-cu.in. unit discussed in connection with condition 1.

3. Emergency operation of hydraulic system—It is conceivable in military applications that the main source of hydraulic power supply, the pump, may be rendered inoperative either by engine failure or failure of the pump itself. It is, therefore, required in a great many military aircraft that the system accumulator be of sufficient capacity to completely operate the landing gear and flaps at least once, and to operate the power brakes a sufficient number of times to insure a safe landing.

4. Secondary hydraulic systems—Many of our larger bombers and heavily armed aircraft employ secondary, complete hydraulic systems operated by their own pumping units independent of the airplane powerplant. The greatest application of this type is the modern gun turret. In this case an accumulator is placed in the system to aid the speed of turret operation. A very recent application of the same type has been the use of an accumulator in the hydraulic system of the hydrodynamic propeller. This was found necessary because the greatest need for hydraulic power to change the pitch of the propellers arose when the engines were turning slowly. Consequently the hydraulic cylinder received an insufficient quantity of fluid to meet the time requirements for actuation.

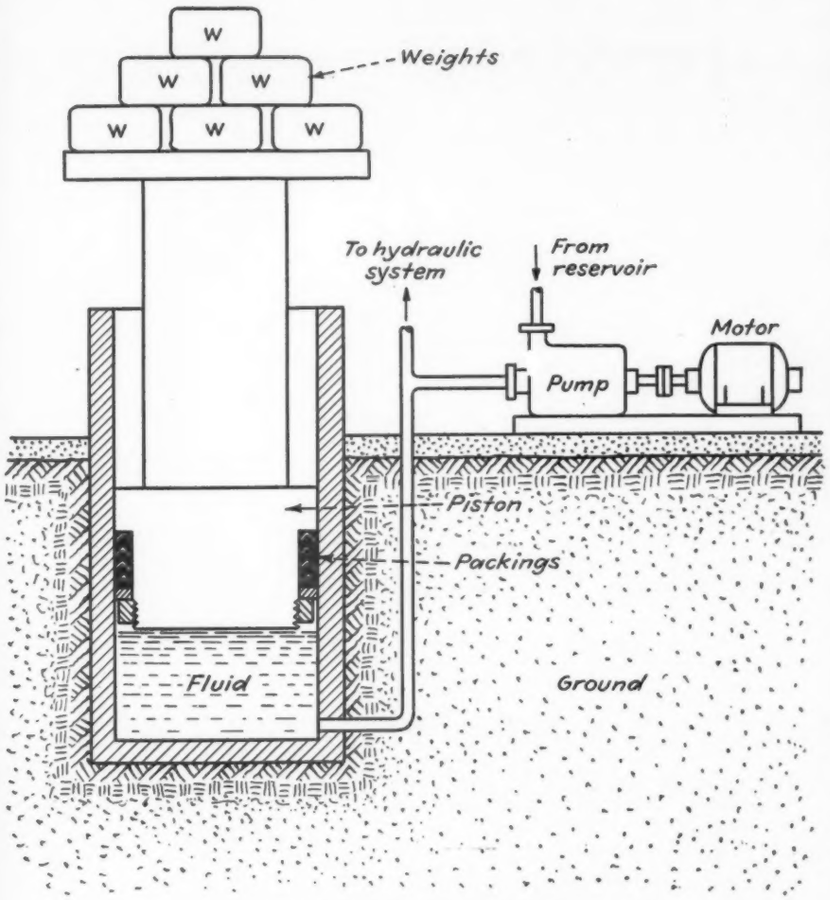



*Fig. 1. Gravity type accumulator.*

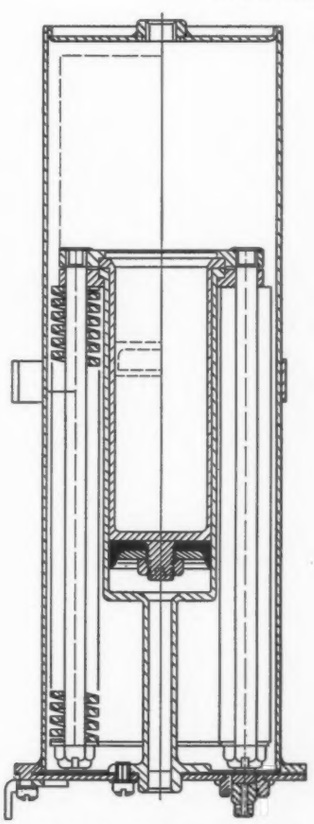


*Fig. 2. Spring-loaded accumulator (Air Associates, Inc.)*

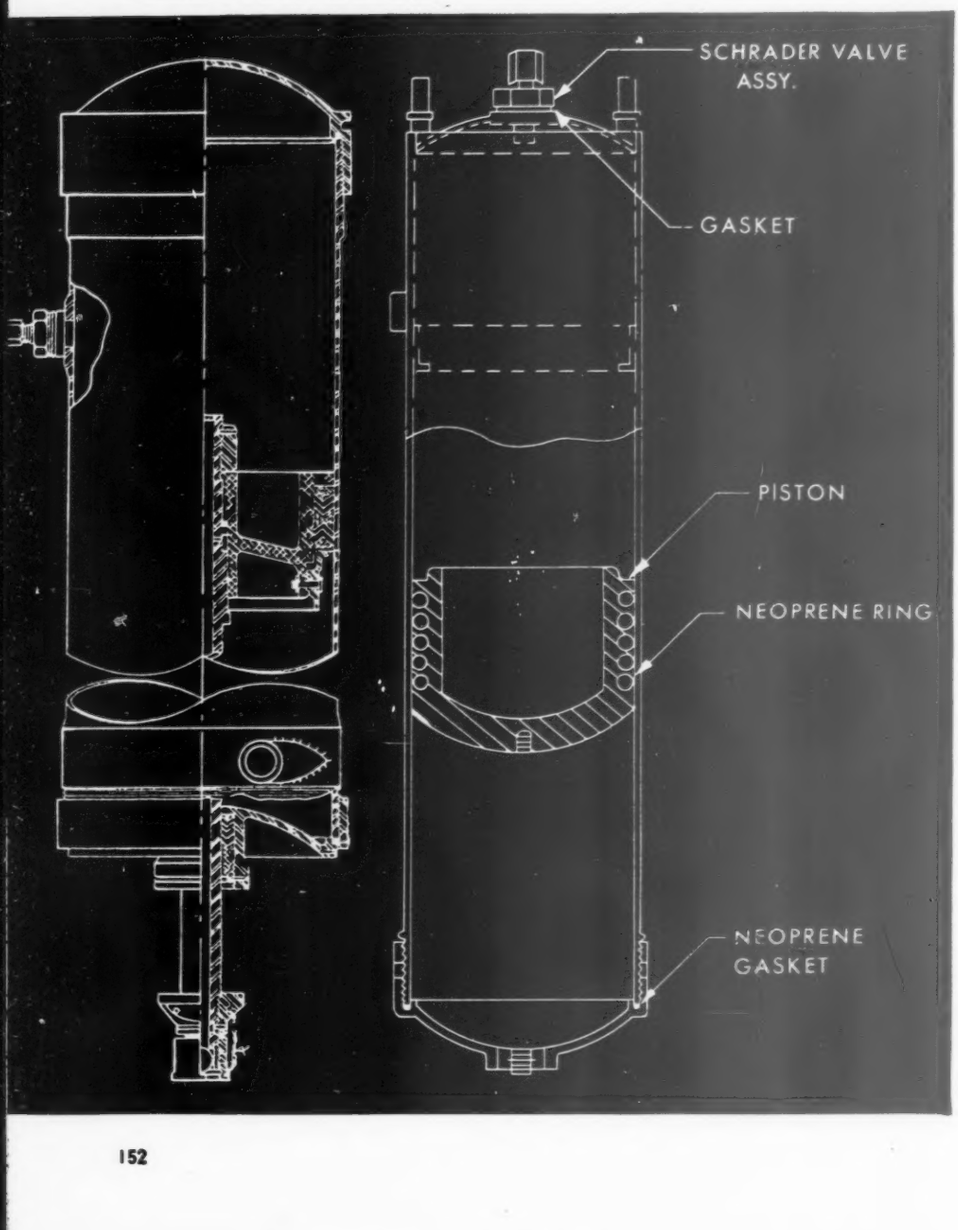
*Fig. 3. Industrial spring-loaded accumulator.*

## Development of the Accumulator

In order to appreciate and understand the applications of any product, some knowledge of its background and development is necessary. The earliest form of accumulator, known as the gravity type accumulator, is still used in stationary industrial applications today. This accumulator consists of nothing more than a close-fitted piston mounted vertically in a ground cylinder. There is a platform on top of the piston on which heavy weights are placed to correspond with the pressure required in the fluid pumped into the underside of the piston (See Fig. 1). The greatest advantage of this type accumulator is that gravity does the work and that the pressure is constant regardless of the quantity of fluid in the fluid chamber of the accumulator. This latter is a characteristic not found in any other type.

Although perfectly acceptable in stationary plants, it can readily be seen that for mobile applications this type accumulator would not be practical. In order to accumulate sufficient fluid under pressure such a device would be far too heavy and cumbersome for use. Consequently, for use in a dump truck, bulldozer, machine tool and eventually in aircraft a spring-loaded accumulator was developed which is still in use. As shown in Figs. 2 and 3, the spring-loaded accumulator consists essentially of a piston closely fitted in a ground cylinder. A disk is mounted on the piston rod and a series of pre-loaded springs is attached to this disk in such a manner that as the piston rises the springs are further loaded. As in the previous type accumulator discussed above, a fluid chamber under the piston connects to the pump and hydraulic system.

*Fig. 4. (Left) Pressure tank accumulator. (Douglas Aircraft Co.) Fig. 5. (Right) Floating piston accumulator (Boeing Aircraft Co.)*




The great disadvantage of this type accumulator is that a very small quantity of fluid can be stored to be called on to do useful work. In many cases this is as little as a few cubic inches. Therefore, in most applications the spring-loaded accumulator is used merely to prolong the periods between unloading in the pressure regulator.

As the size and speed of aircraft advanced, the demands on hydraulic actuation progressed to a point where large volumes were required from hydraulic accumulators. In order to meet these requirements for large volumes of accumulated fluid under dynamic pressure, the air-loaded accumulator was developed. The Douglas Aircraft Company, long a leader in the development of hydraulic actuation in the aircraft industry, developed its first air-loaded accumulator for the DC-3. This accumulator is still in general use on all our major commercial airplanes. The Douglas accumulator shown in Fig. 4 is of the piston type, patterned in design after the typical actuating cylinder as used in hydraulic applications. This accumulator consists essentially of a piston fitted closely to a ground and honed cylinder. A piston rod connects to the piston which extrudes through the lower head of the assembly and is sealed from leakage by means of a V-type packing box in this head. The cylinder is closed on the upper end by a cylinder head which screws onto the cylinder with appropriate seals to prevent leakage. A shock strut type air valve is mounted near the top of the cylinder through which a pre-load charge of air or nitrogen can be introduced. An oil port at the bottom of the cylinder allows oil to be pumped into the lower chamber. The piston itself acts as a separator between the air and oil chambers and contains suitable packings to prevent leakage or mixture. The piston rod extends outside the cylinder so that it acts as an indicator as to the quantity of oil accumulated in the unit.

Although this type accumulator represented a great stride from previous designs, it was quite troublesome from a service and maintenance standpoint. The packings deteriorated and leaked and have been from the beginning a source of constant trouble. It was as a result of the experience gained in this accumulator that the spherical diaphragm type accumulator developed.

However, inasmuch as the Floating Piston Accumulator is in general design the same as the unit discussed above, and since this accumulator is in use in many aircraft today, special attention must be given it here. As can be seen in Fig. 5, this device consists essentially of a piston containing the newly devel-

oped "O" ring packings, closely fitted to a honed cylinder which is closed off on each end with suitable cylinder heads which in turn contain packings to prevent external leakage. One cylinder head contains a shock strut type air valve, the other contains the oil intake port.

The Floating Piston Accumulator is fundamentally sound in design and as a result of the development of the round ring packing technique it gives satisfactory service from a maintenance standpoint. The greatest disadvantage of this unit is its increase in weight over the diaphragm type accumulator. Also, in some cases the cost of manufacture is higher than that of the diaphragm unit.

The most popular type of accumulator used in aircraft hydraulic systems today is the spherical diaphragm type. This

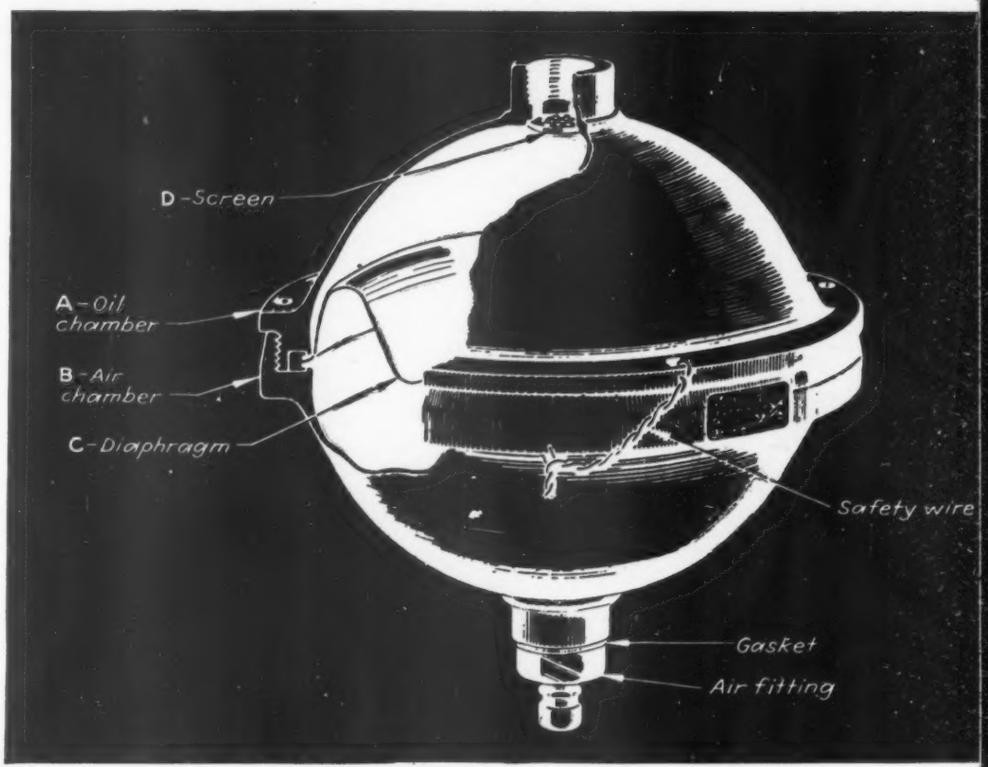



*Fig. 6. Spherical accumulator (Vickers, Inc.)*

*Fig. 7. Bottle type accumulator (Simmonds Aerocessories, Inc.)*

accumulator type was developed by the Douglas Aircraft Company as an improvement over their cylinder type unit. This company and its subcontractors have been producing a large quantity of these units for the use of the Douglas company as well as for use by other aircraft manufacturers. This accumulator consists essentially of two dural hemispheres, bolted together to form the housing. A synthetic rubber diaphragm, mounted as a divider between the two hemispheres, separates the accumulator into two chambers—one for air, one for oil. A boss at the pole of each hemisphere contains either the air intake valve or the oil port.

Today Vickers, Inc., supplies the aircraft industry with the most widely used of these spherical accumulators. Their unit, shown in Fig. 6, consists of two hemispherical steel shells screwed together, and it contains a synthetic rubber diaphragm which separates the hemispheres. Generally speaking, the Vickers unit is identical with the Douglas accumulator. The exception is that the Vickers unit is made of chrome molybdenum forgings screwed together as compared to the bolted dural housings of the Douglas product. However, the Vickers accumulator has definite advantages in weight saving and ease in maintenance.

The Simmonds Aerocessories, Inc., bottle type accumulator is the latest design to enter the field. This component was designed principally to meet the high production needs brought about by the war. Special emphasis in design is placed on simplicity, ease in manufacture and maintenance. As illustrated in Fig. 7, the Simmonds accumulator is of the air-loaded bladder type consisting primarily of a steel shell or housing, a fully enclosed synthetic rubber bladder, molded to a high pressure (automotive tire type) air valve, a dural plug containing a number of strainer holes on one end, a closure nut and synthetic rubber packings.

The housing is of one piece construction (containing no welds or brazed joints) made from steel sheet drawn into a cup and then spun into a bottle. The bladder, the first and only fully enclosed synthetic rubber unit of this type made in this country, is specifically designed to give high volumetric efficiencies and long life.

## Principles of Operation
## Air Loaded Accumulators

Inasmuch as aircraft hydraulic accumulators are all of the air-loaded type, the principles of operation of this type only will be discussed here. These principles cover not only the diaphragm and bladder types but also the floating piston type.

In operation air is pumped into the air chamber through the air valve to its pre-load pressure requirement. Then oil is pumped into the oil chamber through the oil port. The first drop of oil which enters the accumulator must displace the equal volume of air above the piston or diaphragm. Therefore, it must enter at the pressure precharged into the air chamber. As the oil is pumped farther into the accumulator the piston or diaphragm rises,

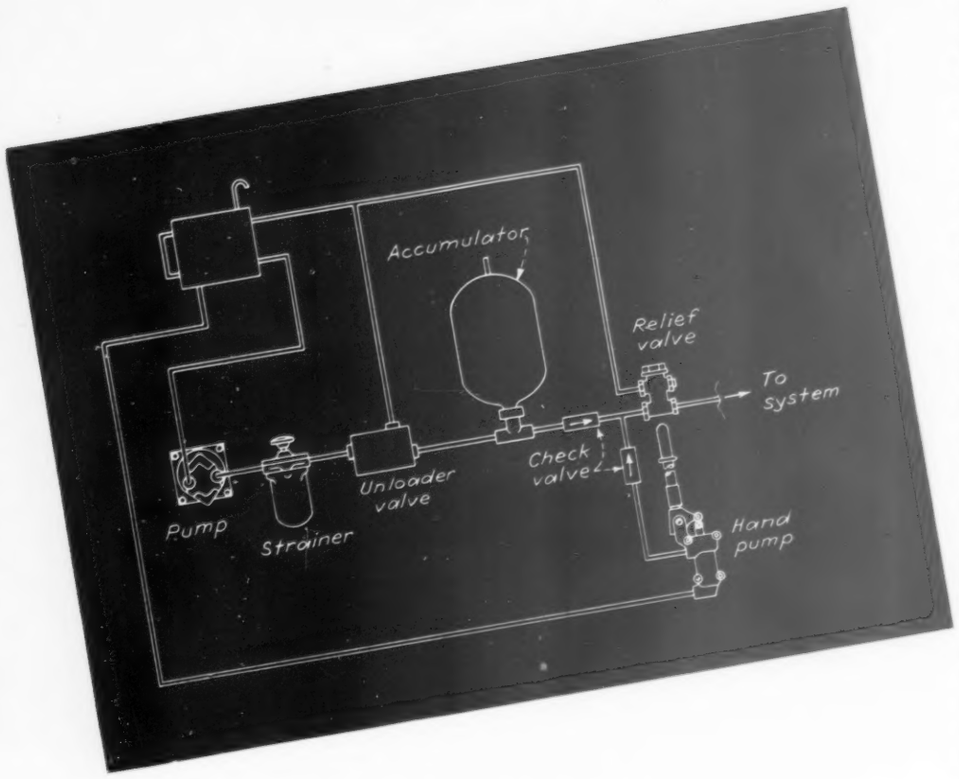



*Fig. 8. Schematic diagram, hydraulic accumulator.*

thus compressing the air in the chamber above it so that at all times equal pressure exists between the air and oil. This pressure is transmitted throughout the hydraulic system which is connected to the pressure side of the accumulator.

Inasmuch as oil is incompressible, the air or nitrogen under pressure acts as a dynamic force in the same way as a spring to maintain the pressure in the accumulator and to force it out under pressure to do work on the hydraulic system. It should be noted here that as the fluid is discharged from the unit, the air expands and the pressure drops. For this reason the pre-load or initial air charge plus the volume of the accumulator must be sufficient to do the work required from the accumulator.

For use in aircraft the "pre-load" or initial air pressure charge has been arbitrarily set at one-half the working pressure, and volume of oil accumulated, calculated so that at the lowest pressure of the fluid complete actuation has taken place. It is unfortunate that the pressure drops as the oil flows from the accumulator into the actuating unit since it is near the end of the stroke of the actuating cylinders that the most pressure is needed in the majority of installations. This results in the use of accumulators which are rather large

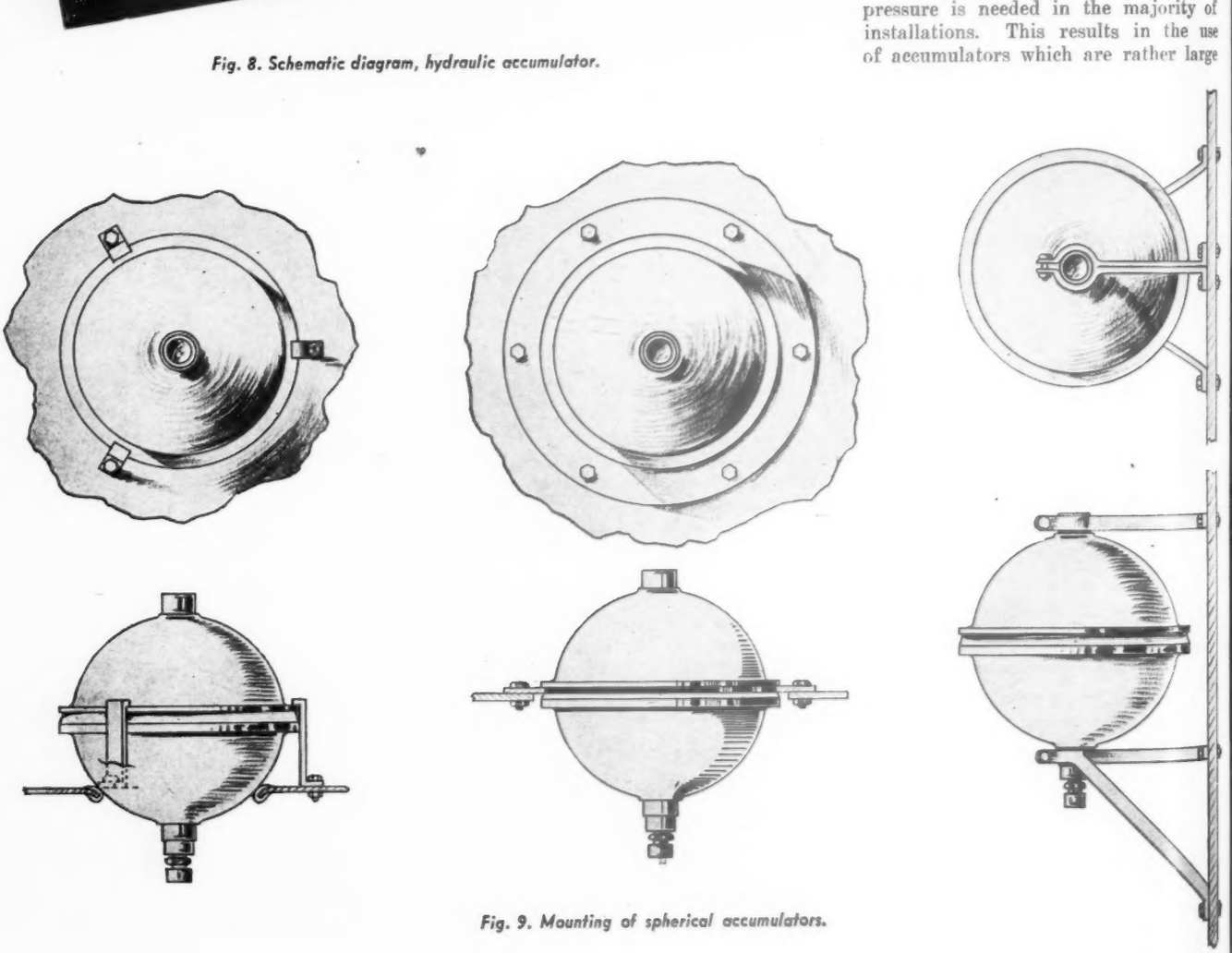
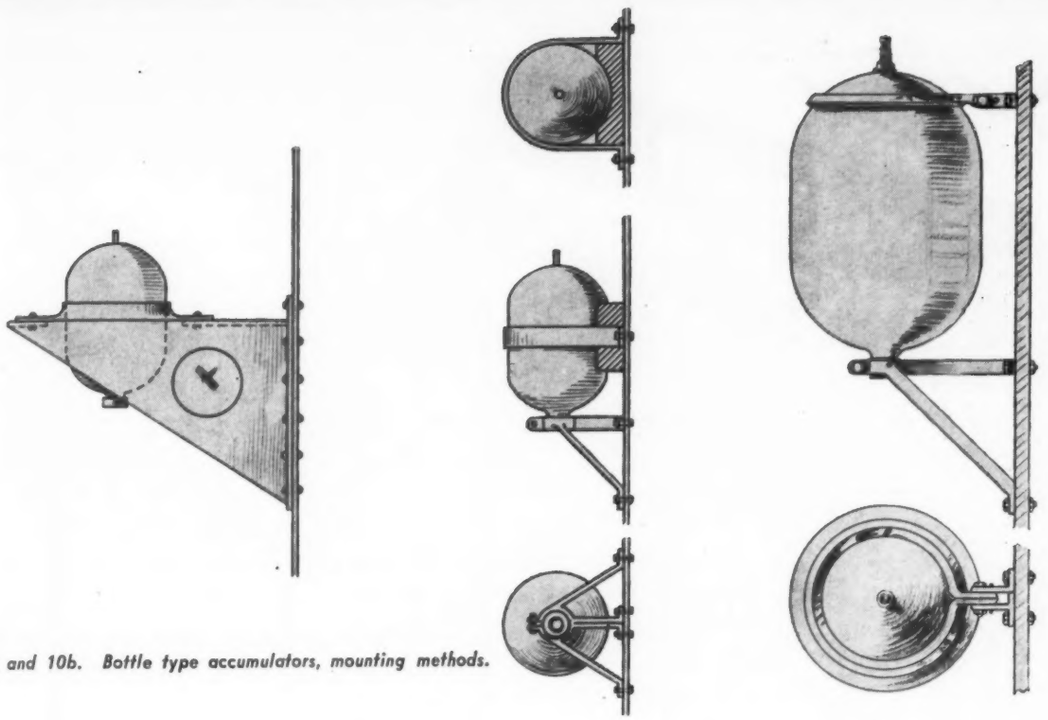


*Fig. 9. Mounting of spherical accumulators.*



*Figs. 10a and 10b. Bottle type accumulators, mounting methods.*

in capacity but are not used generally to the full capacity of their oil chamber. In cases where the full capacity of the accumulator is used, the actuating cylinder diameter is large enough so that at pre-load pressure a complete stroke against the resisting load can be accomplished.

Fortunately in operation the compression and expansion of air in the accumulator is slow enough so that the heat developed can be disregarded in the calculation of volume requirements. Therefore, Boyle's law for gases, $P_1 V_1 = P_2 V_2$, can be applied to determine the air volume requirement. This air volume subtracted from the total volume will give the accumulated oil volume. For example:

If we have an operating pressure of 1,500 psi. and choose a pre-load of 700 psi. need a total volume of 225 cu.in between 1,500 and 700 psi. for complete operation of the hydraulic system. What size accumulator is needed?

We know the air pressure and volume vary as $P_1 V_1 = P_2 V_2$

$P_1$ = Precharge pressure = 700 psi.

$V_1$ = Total volume of accumulator as at pre-load (Accumulator is completely full of air)

$P_2$ = Operating pressure = 1,500 psi.

$V_2$ = Air volume at 1,500 psi.— $V_1 - 225$ cu.in.

because we require 225 cu.in. of oil the rest of the accumulator being air

$\therefore 700\ V_1 = 1{,}500\ (V_1 - 225)$

$= 1{,}500\ V_1 - 337{,}500$

$800\ V_1 = 337{,}500$

$V_1 = 422$

∴ Choose nearest commercial size which is 515 cu.in. and redesign the minimum to a higher level keeping pre-load pressure as is.

To determine pressure available after 225 cu.in. of oil has been exhausted from the accumulator, proceed as follows:

$P_1\ V_1 = P_2\ V_2$

$700 \times 515 = 1{,}500\ V_2$

$1{,}500\ V_2 = 360{,}000$

$V_2 = 240$ cu.in. air

Volume oil = 515 — 240 = 275 cu. in.

after exhausting 225 cu.in.

Volume oil = 275 — 225 = 50 cu. in.

Pressure available with 50 cu.in. oil accumulated

$700 \times 515 = P_2\ (515 - 50)$

$360{,}000 = 465\ P_2$

$P_2 = 775$ psi.

∴ The system can be designed for a minimum operating pressure of 775 psi.

## Installation of Accumulator

In order to save weight in oil and tubing it is best to install the accumulator as close to the hydraulic pump as possible. Since the pump is generally mounted on the engine, it has been found in most applications, the best location is in the nacelle section generally on the firewall directly behind the engine. Also, in this location the heat of the engine aids the operation of the hydraulic system in keeping the accumulator warm in sub-zero flight conditions. In addition, there is the added advantage of lessened vulnerability to gunfire inasmuch as bullets would have to pierce the engine to get to the accumulator in frontal attack or go through the armor-plated pilots' compartment in rear attack. For most efficient operation of the unloader valve, the length of tubing between it and the accumulator should be as short as possible.

A typical installation showing the power circuit in schematic diagram is shown in Fig. 8. In this figure it can be seen that the accumulator is placed between the unloader valve and the relief valve. For ease in handling and servicing the accumulator can be mounted on a panel with the unloader valve and strainer. This panel assembly forms a unit which can be mounted on the airplane and removed as a unit for servicing.

Based on a recent series of tests made with a transparent lucite accumulator, it is the opinion of the writer that wherever possible the hydraulic accumulator should be mounted in a vertical position with the air chamber above the oil. When the accumulator is mounted with the air chamber below the oil, the forces set up by the buoyancy of the air and its attempt to rise above the oil set up severe stresses in the diaphragm and generally distort it. This cuts the life of the separator a great deal. On the other hand with the air above the oil, the action of the separator is smooth and takes its normal, designed shape in the accumulator. Aside from this it is generally easier to get to the air valve for preloading when it is on the top end of the accumulator. It has been found in these tests that almost 100 percent efficiency can be obtained with the air above the oil, and any air that may enter the accumulator from

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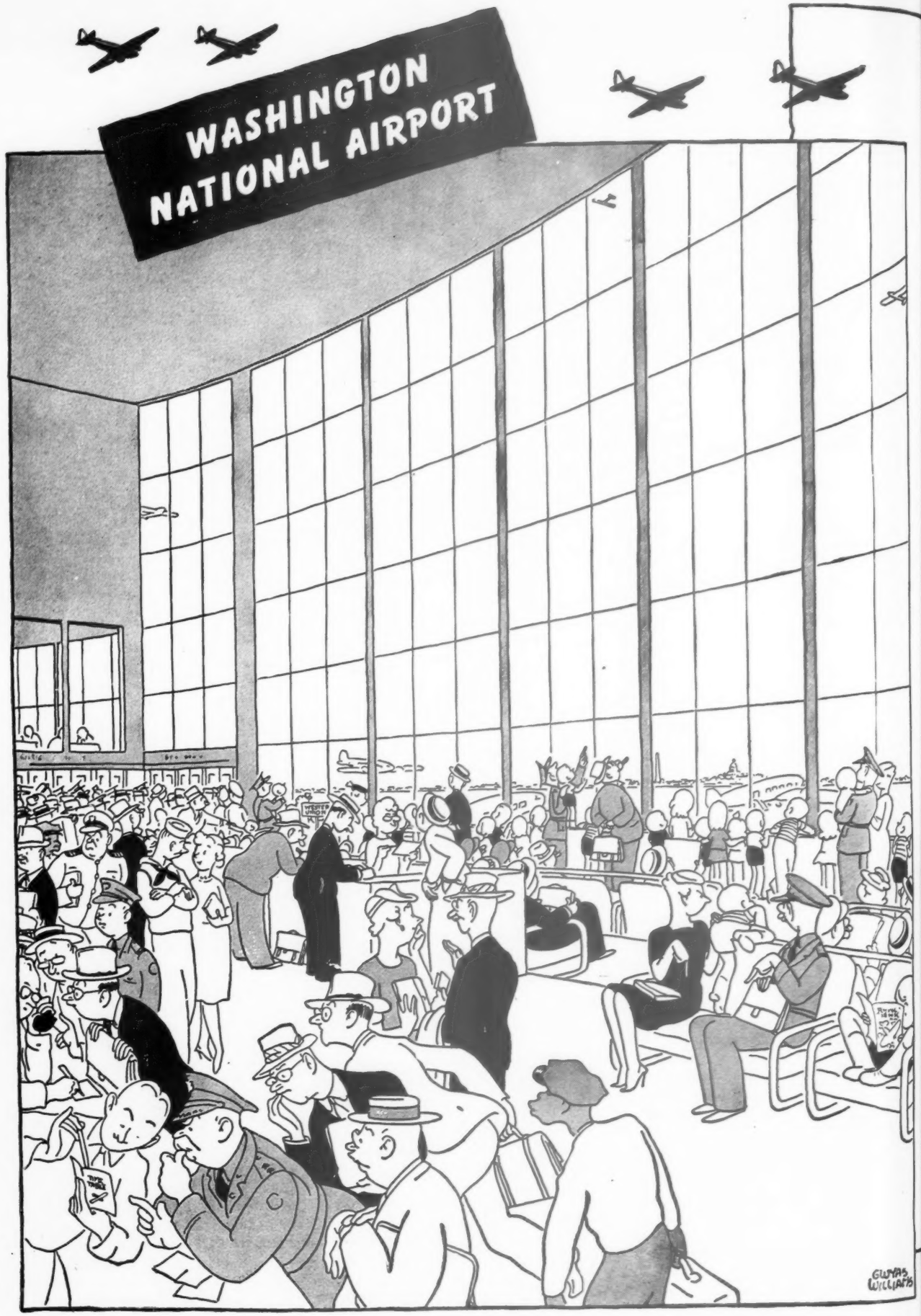
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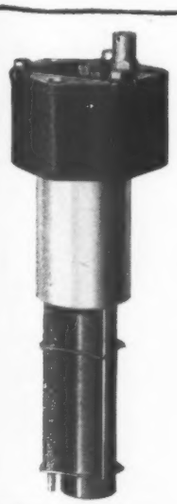

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# FABRICATING DROP HAMMER DIES

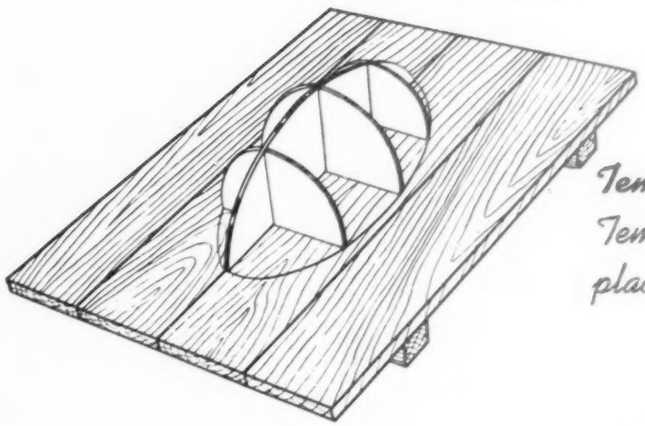
**Some new ideas applied to an old technique facilitate handling and efficient utilization of drop hammer dies.**

By CHRIS J. FREY,
*Brewster Aeronautical Corp., and*

STANLEY S. KOGUT,
*Eastern Aircraft Production Forum*

Although the present article describes graphically the standard procedure in the fabrication of dies, several innovations are explained which speed production materially.

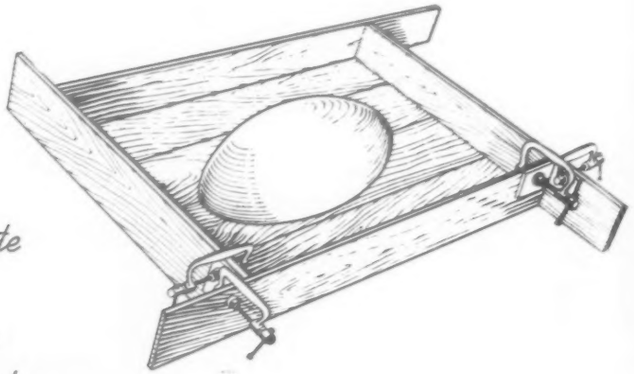
These are the clamping lugs, cast integrally with the dies, removable dowels which provide convenient attachments for handling and removable studs which simplify storage.



*1.*

***Template skeleton***

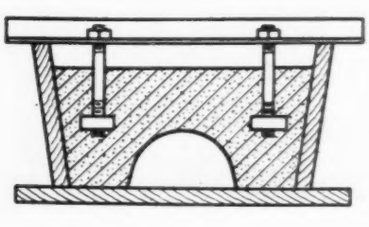
*Template skeleton of part to be made is placed on a board. Plywood may be used.*



*2.*

***Plaster model (in form).***

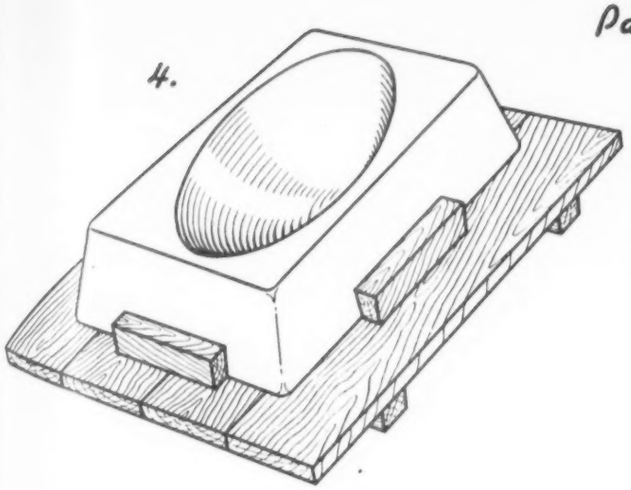
*Plaster is packed in around the template to form the model which is then surrounded by a box whose size can be adjusted by means of angle irons and clamps. Sides of box should slant outward at an angle of about 3°. Clay, plaster or wood may be used for pattern.*



***3. Plaster pattern section showing lifting bolts in place.***

*The frame is then filled with plaster into which a set of nuts and bolts are suspended by means of an angle iron. This is used to draw off the pattern.*

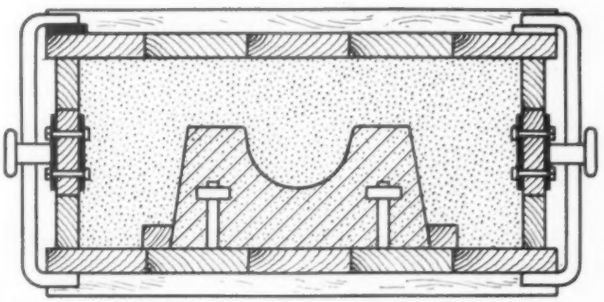
4.



**Pattern on bottom board of flask showing blocks for clamping lugs.**

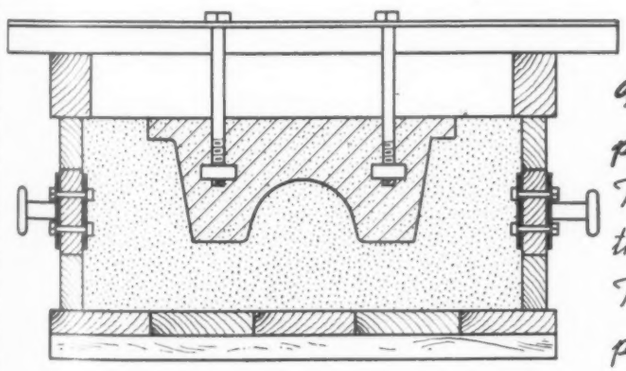
Bolts are screwed out but nuts are left in. Plaster pattern is laid on a board with pieces of wood around it. These will later form clamping lugs.

5.



**Assembled flask—with sand. Note clamps in place.**

Flask is placed on bottom board surrounding the plaster pattern. It is packed with sand and covered with another board. The studs on the side of the flask are centered so as to provide an easy means for turning it over.



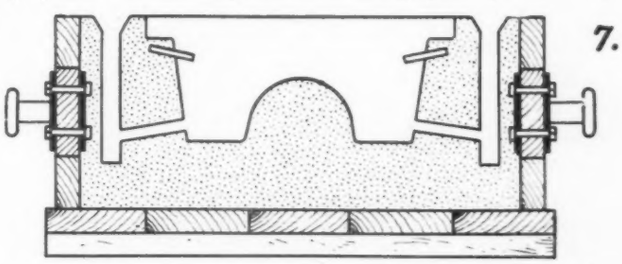
6.

**Flask inverted—ready for removal of pattern.**

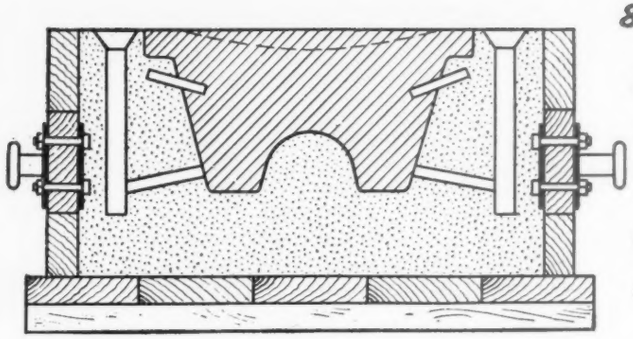
The assembly is turned over and the board that was formerly on the bottom is removed. The angle iron is used to draw out the plaster pattern.

**Sand mold with pins to create lifting pin holes—gates ready for pouring.**

Steel dowels coated with graphite are inserted into the sand at an angle. Pouring gates are cut and metal is poured.



7.



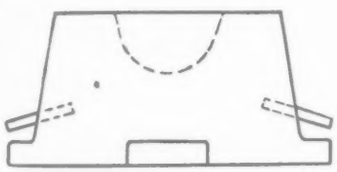
8.

**Die in sand—showing cavitation that must be corrected.**

Shrinkage generally takes place during cooling and more metal must be poured to obtain a flat bottom for the die.

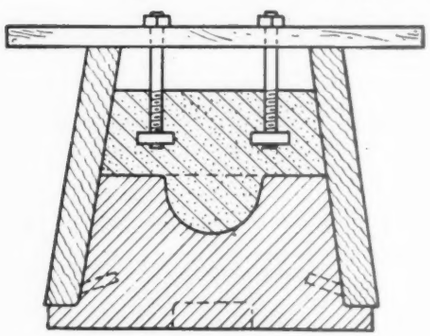
**9. Completed die ready for punch.**

After cooling the die is removed. The dowels can be easily removed from the die for reuse in other molds. Pins on sling are inserted into the holes for lifting. Note clamping lugs.



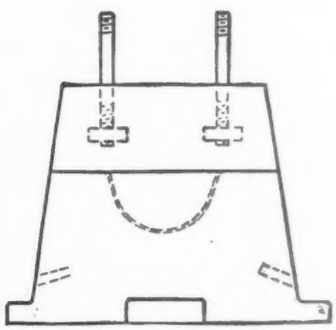
10.

**Adjustable steel frame around die—ready for pouring. Bolt spacing fixture in place.**



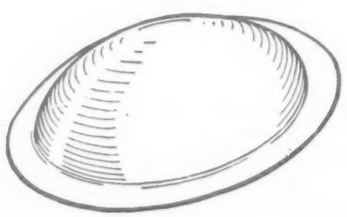
An adjustable steel frame is placed around the die, fastened with wedges, over size removable studs and nuts suspended in it and the Lead Antimony punch is then cast into the die.

Studs can be removed for reuse—die storage is facilitated.

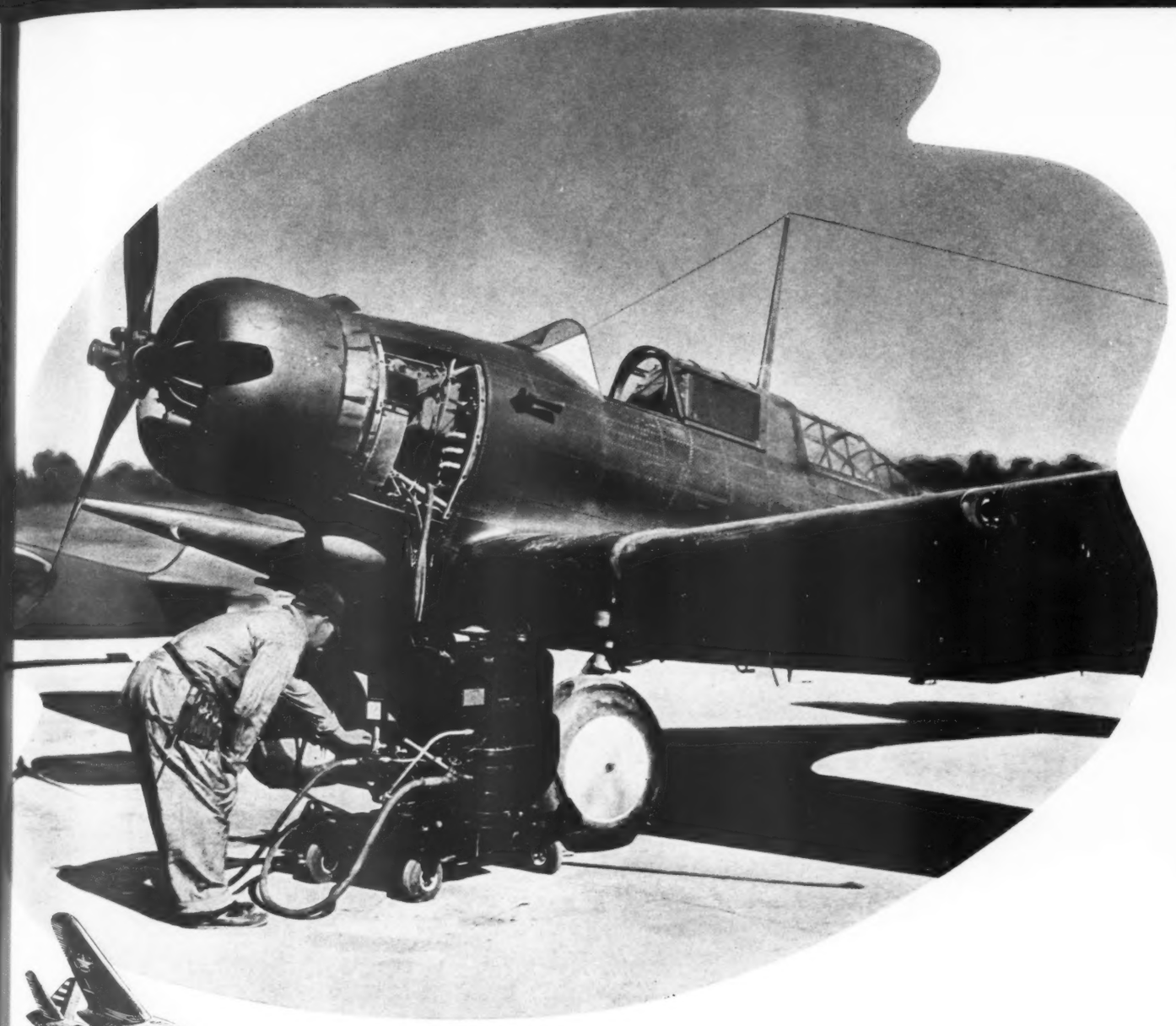


**11. Completed punch and die.**

Standard studs in punch.



**12. Manufactured part.**



# AVIATION'S NEW RIGHT HAND... *at work!*

Aviation's New Right Hand is busy getting them into the air and seeing to it that they stay in the air.

From the production of aircraft engine crankshafts to actual maintenance tests in the combat zone, Denison HydrOILics is becoming more and more important in America's drive to keep 'em flying . . . in helping build and maintain the world's finest air force . . . in protecting craft and crews against accidents.

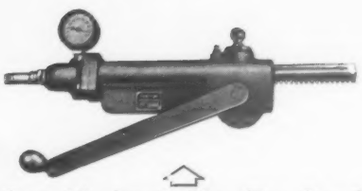
On this page is an example of one of the ways oil hydraulics is helping out on tough jobs . . . a Denison HydrOILic test stand checking the hydraulic circuit of an attack plane. Powered by a gasoline engine, and used in the field—or where electric power is not available — it checks aircraft hydraulic systems using extremely high operating pressures. An electric-motor driven unit, illustrated on the following page, performs even additional services. Check the many important tasks in aviation now being handled by . . . . . .

**HydrOILics**

## THE DENISON ENGINEERING COMPANY, COLUMBUS, OHIO

Denison electric-motor driven HydrOILic Test Stand for testing aircraft hydraulic systems using up to 3,000 pound pressures. Self-contained reservoir, accumulator, and valve control provide for testing and adjusting individual units of the system. Twin oil filters, with individual selector valves, are provided.

Denison Burst Test Stand for determining burst pressures of devices in hydraulic systems.



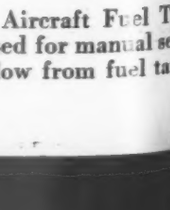
Portable Spark Plug Test Stand for field use, providing a manual mechanical means of subjecting spark plugs to high pressures so that electrical performance can be checked by an auxiliary unit.

HydrOILic Spark Plug Test Stand, for testing aircraft spark plugs in conjunction with an auxiliary aviation ignition tester. Plugs are subjected to selected pressure and high voltage. Automatic control assures voltage passing through the plug only when predetermined pressure is reached, and while readings are made.

You'll find Denison HydrOILics producing war materiel in plants all over the country . . . presses assembling critical parts, valves and controls operating important equipment, and test units assuring safe operation. On these pages are eight examples of the new help Denison oil hydraulics is giving just one industry — Aviation.

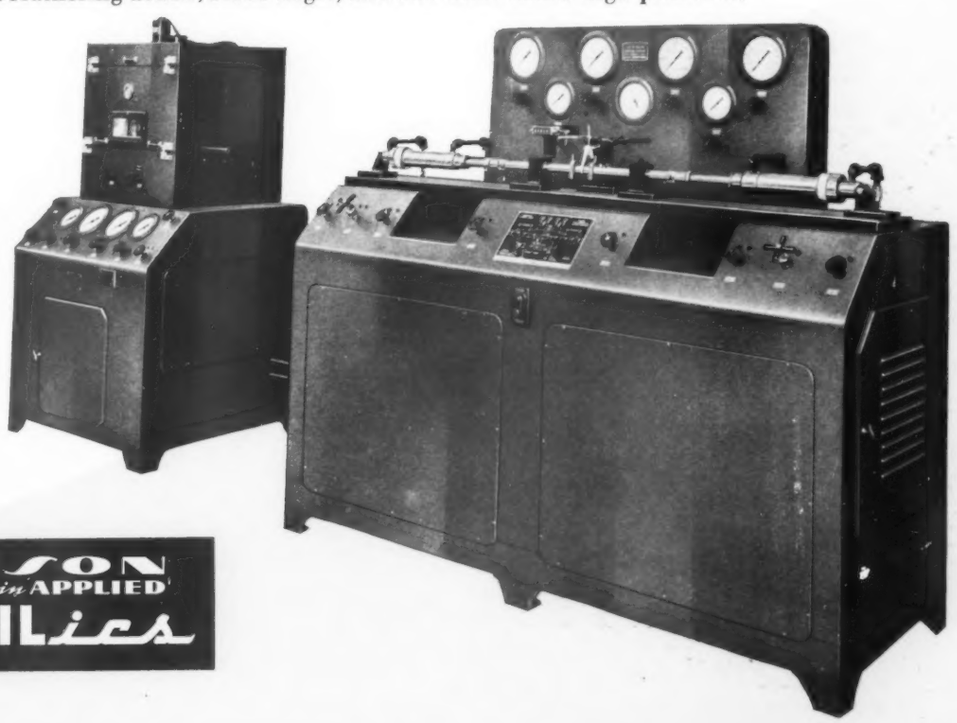
From these illustrations you'll see why HydrOILics has become the Aviation Industry's New Right Hand. The work of Denison engineers has opened a new range of applications for oil hydraulics, made it a better, faster, and more economical way of solving new problems and improving old methods.

Magneto Test Stand, for testing airplane magnetos at speeds from 50 to 6500 r.p.m. Tests can be made at room temperature or, under the dome, at various conditions of heat, humidity, and altitude. Coming-in speeds, insulation, sparking, flashover, voltage-constancy, and shunting resistance can be tested. Operating temperature of the stand can be controlled for making life tests. A similar portable magneto test stand, without altitude equipment, is available for maintenance service.



Denison Aircraft Fuel Tran Valve, used for manual selecti of fuel flow from fuel tanks.

Hydromatic Propeller Test Stand, for testing distributor valves and feathering action of Hydromatic Propellers. Valves are checked by a special collar and pressure indicator. With dome installed, tests can be made for feathering action, blade angle, and seal-leaks under high pressures.



Denison HydrOILic Packing Test unit, for testing aircraft hydraulic packings. Static pressure tests, and life tests at selected pressures, can be conducted with this unit. The companion unit, at left, provides for packing tests under controlled temperature conditions ranging from sub-zero to 165° F.

DENISON EQUIPMENT in APPLIED HydrOILics

# INDUSTRY'S NEW RIGHT HAND

The advantages of fluid power transmission as applied in HydrOILic equipment for aviation needs, are just as applicable to all industries. Flexibility of application . . . widely variable adjustment . . . precise and positive control . . . all of these sought-for features are being applied by Denison engineers to the already proved advantages of oil-hydraulic power. HydrOILics has truly given industry a *new right hand!*

HydrOILics is hard at work on tasks of pushing, pulling, pressing, tilting, clamping, positioning, and similar operations. It is *pulling* massive units of equipment back and forth into position with quiet ease and complete control . . . *pressing* the toughest metal parts to straighten irregularities of as little as a few thousandths of an inch . . . powerfully *clamping* structural or machine parts to speed up and simplify assembling operations . . . *positioning* large parts or equipment for greater accessibility during production. Ask us how HydrOILics can be applied to *your* specific needs. Call your Denison representative, or write directly to the factory.

*This 20-ton Denison horizontal press is doing in 2½ minutes a job that formerly required ten . . . the assembly and disassembly of airplane engine crankshafts. The crankshaft is locked in the fixture in three sections, and HydrOILics does the rest with speed and power, under complete control of the operator. War-rushed plants all over the country are getting help like this from Denison equipment in applied HydrOILics.*

## THE DENISON ENGINEERING COMPANY

1166 DUBLIN ROAD COLUMBUS, OHIO

BULLETIN NUMBER DE-5

*LEFT: Eric Dudley, of Buffalo, elected national chairman of National Aircraft Standards Committee for year 1942-43, at November meeting in New York. He is in the Curtiss-Wright Airplane Division. . . . RIGHT: John Cramer, Seattle, standards engineer for Boeing Aircraft Co., past national chairman of National Aircraft Standards Committee for 1941-42.*

# *Aircraft Standards Committee Program Keyed to War Needs*

**Fourth annual meeting of the National Aircraft Standards Committee convened in New York, Nov. 9-13. Groundwork laid for setting up dimensional standards in aircraft raw materials sizes.**

By GLEN M. ARON, *Standards Engineer, Northrop Aircraft, Inc.*

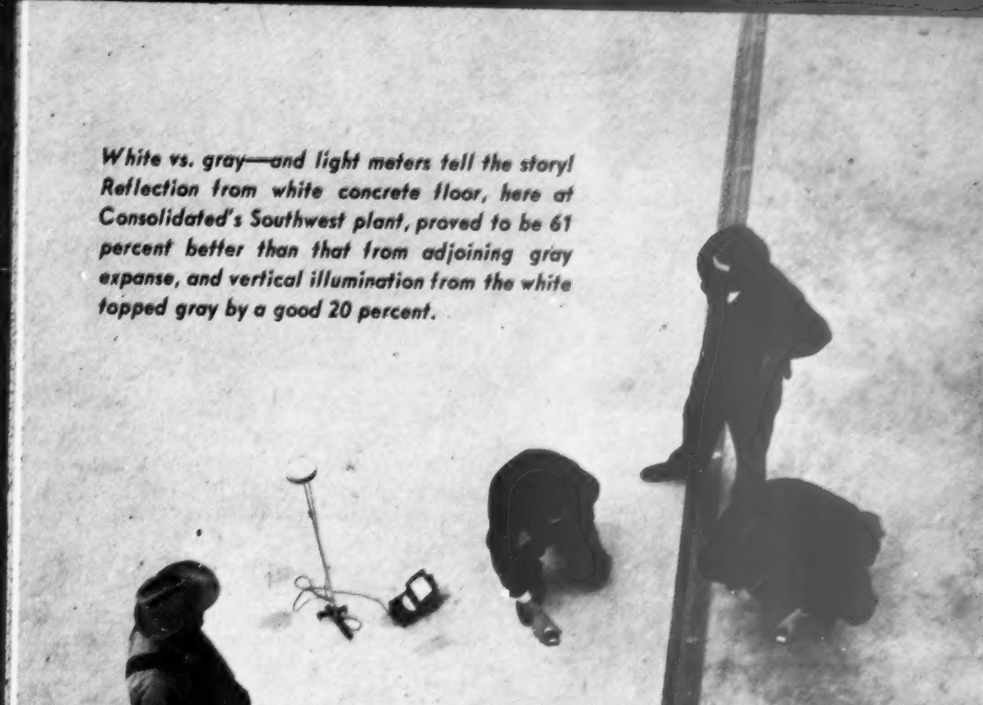
"WHENEVER I have had to cannibalize a wrecked airplane to keep another in service, I have offered a prayer that the standards engineers had done their job well!" These words of Tye Lett, Jr., in his article titled *We Learned War Maintenance With the AVG* (page 104), should in this war time be the angel spirit which guides the life and work of every standards engineer in the business.

With the adjourning of the combined National Aircraft Standards Committee in New York City in November, and as each representative to the committee goes home to make his report to his chief engineer, it is time to ask the question of the standards committee and the entire industry, "What authority of position shall we give to standardization in American aircraft, and how strong shall we make the program?"

Everyone who has been delegated to the committee since its feeble start in June, 1939, in Los Angeles, knows that aircraft standards have come a long way. There were Army and Navy standards, with those of industry before the concept of the NASC, and there are seasoned standards in allied industries through engineering societies, committees and institutions all represented in the American Standards Association. The present major standards program for aircraft among the prime contractors began in November, 1940, when the Eastern and Western

(*Turn to page* 351)

*Delegates representing major aircraft companies photographed during session of National Aircraft Standards Committee Meeting at Lexington Hotel, New York, Nov. 9-13. Seated—left to right: J. E. Thompson (Vultee); A. M. Stutz (Stinson); Charles Sardou, Jr., vice-chairman, West Coast (Vultee); G. T. Waite, chairman, West Coast (Consolidated); Eric Dudley, national chairman (Curtiss-Wright); W. D. Craig, Jr., chairman, East Coast (Grumman); W. H. Colcord, vice-chairman, East Coast (Kellett Autogiro); E. W. Norris, office of national chairman (Washington, D. C.) and Miss Kelleher (secretary to E. W. Norris). Standing—left to right: Glen Aron (Northrop); L. P. Wood (Curtiss-Wright, Ohio); Lieut. Comdr. A. M. Blamphin (Working Committee of the Aeronautical Board); D. McCalla (McDonnell); C. E. Wingate (Vought-Sikorsky); J. F. Cramer (Boeing); J. H. Gunning (Douglas); J. Perina (Republic); T. P. Hearne (Ryan); J. M. Townsend (Hughes); J. F. Hammond (Boeing); E. E. McCormack (Vought-Sikorsky); M. A. Schulteis (Lockheed); W. M. Smith (Bell); Jerome Gropper (Brewster); J. F. Cox (Vega); John Kay (Brewster); C. T. Torresen (North American); George W. Baughman (Cessna). J. T. Thompson (Martin) and F. M. Salisbury (Douglas), also attending the meetings, were absent at the time picture was taken.*



*White vs. gray—and light meters tell the story! Reflection from white concrete floor, here at Consolidated's Southwest plant, proved to be 61 percent better than that from adjoining gray expanse, and vertical illumination from the white topped gray by a good 20 percent.*

WHITE FLOORS

# LIGHT Those Under-Wing Shadows

**By sending 61 percent more light beneath wings, 20 percent more on vertical faces, easily maintained white flooring makes seeing easier, quicker . . . reduces accidents, errors . . . "ups" quality and production. What's more, Consolidated sights a $30,000 first-year saving in lamp fixtures, maintenance, and power.**

By **F. L. MABIE**, *Manager, Atlas White Bureau, Universal Atlas Cement Company*

PROBLEM: To find an efficient way to bring an adequate amount of light to the undersides of wings and fuselages which hide much of the light from above, thus dimming under-wing and vertical working planes. Solution: Light-reflecting floors made with *white* cement.

Fact is that though walls and ceilings have long been recognized as giant reflectors and diffusers of light, it is only in recent years that the use of floors for this purpose has been given its due —and decidedly deserved—consideration.

It was construction of military aircraft which brought attention to the previously overlooked reflection values of floorings. Boeing, Consolidated, Douglas, and North American initially installed light-reflecting white cement floors in assembly plants in 1941—to find them so satisfactory that they are now installing "more of the same" in new plants being completed.

"But," ask most people, "aren't white floors difficult to maintain?" Frankly, experience shows they are not. According to foremen, white floor maintenance —frequent sweeping, occasional damp mopping, and periodic scrubbing—is neither more difficult nor more costly. Says the maintenance engineer at Consolidated's Southwestern plant: "It's just as easy to keep our white cement floor clean as our gray cement floor. Further, white promotes cleanliness."

Standard routine calls for sweeping daily, damp mopping once a month, and scrubbing with a rotary brush machine every two or three months.

Having adjoining floors of gray cement and of white cement, separated only by an expansion joint and with identical lighting facilities over the areas, the Consolidated plant in question, designed and built by the Austin Company, provided a pertinent basis for study and comparison of the floorings.

An extensive illumination survey (described in *Electrical World*, July 25, 1942) was made by the General Electric Co. over these adjoining floors, and in addition the plant engineer made comparative studies when the floors were new and after they had been in use six months. And it was shown:

1. That the white cement floor reflected 61 percent more light than the gray—throws 61 percent more light on the undersides of wings and fuselages,
2. That this higher reflection factor increases vertical foot-candles 20 percent,
3. That when lamps needed renewal and floors and lighting fixtures were as dirty as they were expected to get, the white floor retained more of its reflecting value than the gray.

To obtain the same high vertical footcandles over the gray cement as was effected with the white would, it was calculated have increased cost for lamp fixtures, lamp maintenance, and electricity by 20 percent, or more than $70,000. And that $70,000 figure is more than $30,000 above the extra cost of the white floor.

What's more, there is an additional potential saving of some $23,000 in air conditioning expenses, for extra light fixtures would mean extra heat, requiring an additional air conditioning expenditure.

Worth of the better illumination contributed by white cement floors is far reaching. By making seeing easier and quicker, both quality and quantity of production are increased, while accidents are reduced, as well as errors and spoilage, and there is thus an added safeguard against work stoppages.

Noting that concrete may be used to retop old floors, it may be pointed out that the white product, a true portland cement, offers the same dependability, strength, and uniformity as the standard gray, and the materials are readily available. Moreover, since floor surfacing must resist abrasion and withstand heavy traffic, white concrete is certainly to be championed over less permanent white materials when the goal is attainment of maximum light reflection. For instead of being "skin deep," the low-maintenance white concrete offers "built-in" strength and longevity.

Wherever the illumination, production, and protection factors are important, the white floorings may be considered—not only in assembly plants and hangars but also in laboratories, offices, and numerous other buildings. In stair wells, corridors, and the like, too.

Fundamentally, while walls are effective reflectors only within close range and while ceilings are often ineffective reflectors because of girders, overhead equipment, etc., these floors which we have too long neglected as illuminators provide large uninterrupted areas to reflect and diffuse light where it is so much needed—close to the working plane. Such underside and vertical-face reflection is particularly important in aircraft tasks where considerable work is underneath wings and fuselages and on vertical surfaces.

Dark areas or shadows are either decreased or eliminated, and meanwhile a light background is offered against which numerous machine parts may be delineated. By their very expanse, light-reflecting floors distribute light throughout the broad working area, thus making seeing easier and quicker.

White floors provide a background with a degree of brightness more comparable to the materials worked on in the industry, thus they promote ease of seeing by reducing contrast between the seeing task and the surrounding background. Psychologically, the white floor enlivens the employee's attitude and quickens his step, while promoting cleanliness, orderliness, safety, health, and morale. Consolidated employees *prefer* to work on the white flooring.

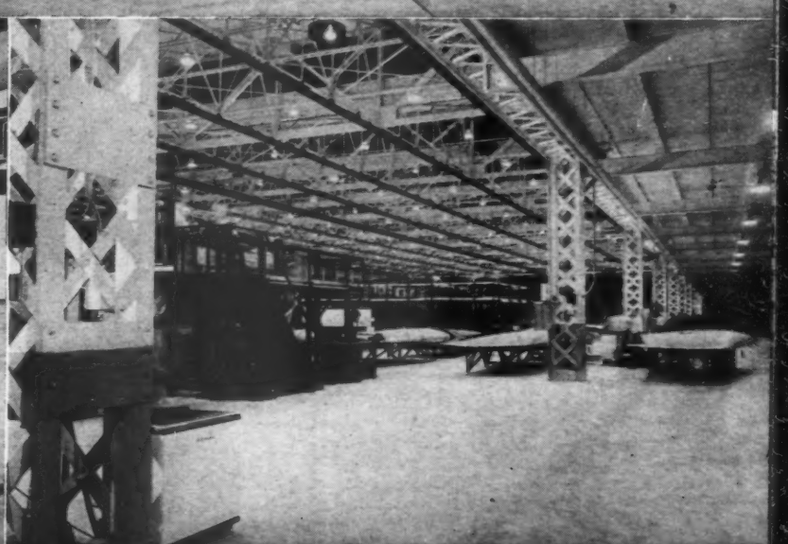
Possibilities in potential betterment via white floors may be sighted in the September, 1942, estimate that an additional 40,000,000 sq.ft. of floor area will

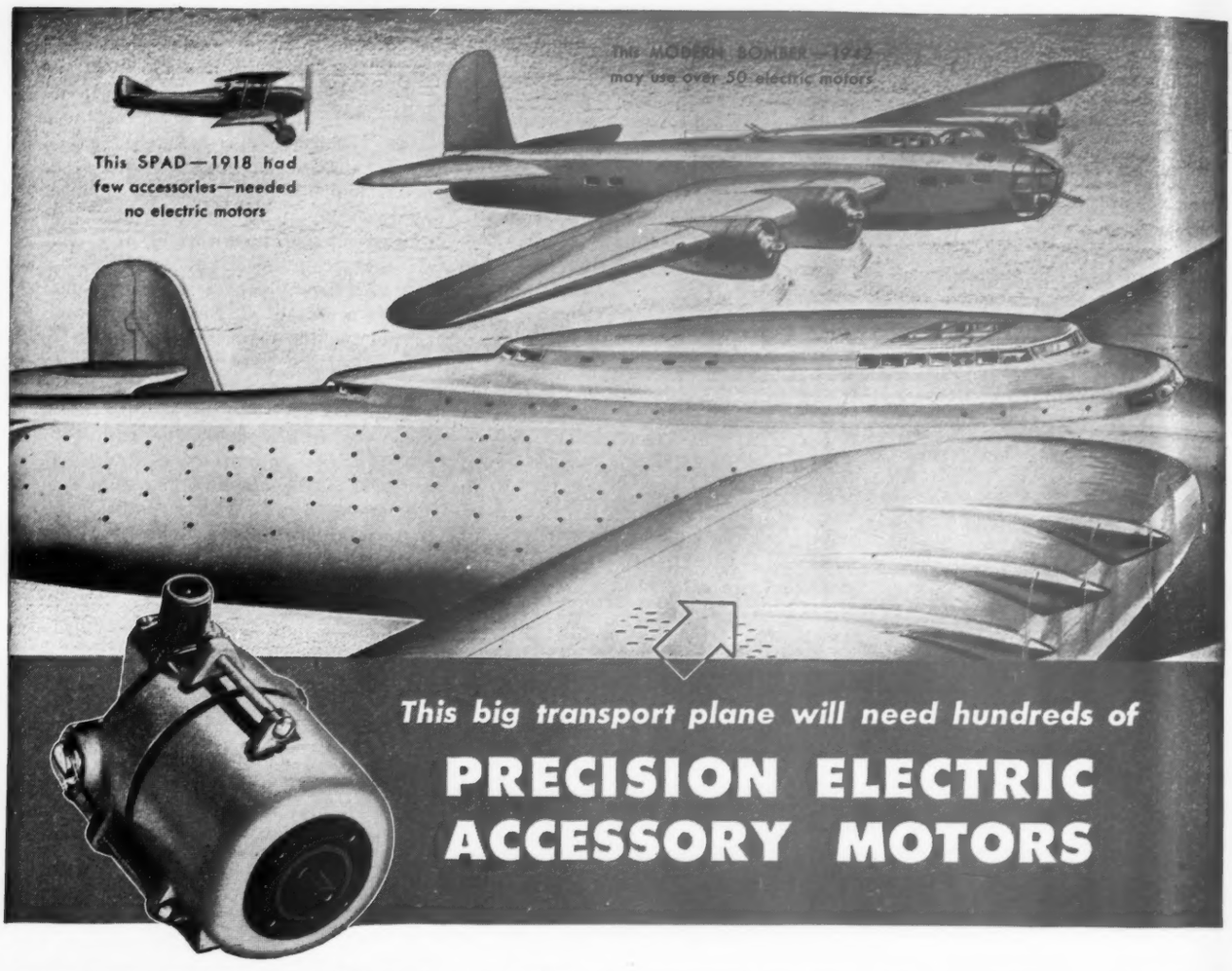
(*Turn to page* 301)

*RIGHT: That white floor "quickens the step, enlivens the attitude" is affirmed by single glance down well-illumined rows of "Liberators" in Consolidated assembly plant. Workers prefer to "work on the white." Camera study indicates clear easy-on-the-eye visibility throughout working area. There is no glare.*

*BELOW AT RIGHT: Further proof of effective reflection and diffusion of light via white floors is offered in this night view at Austin-built Midwest Boeing plant. There are no deep shadows, no sharp contrasts. White girders, ceilings aid light distribution.*

*BELOW: How high-reflecting white floor strikingly improves underside illumination of wings and fuselages is evident in this North American Aviation Midwest plant photo. Note perfect clarity (left) of B-25's insignia. J. Gordon Turnbull was architect and engineer of plant, while MacDonald-Tarlton-Patti was contractor.*




This SPAD—1918 had few accessories—needed no electric motors
This MODERN BOMBER—1942 may use over 50 electric motors
This big transport plane will need hundreds of
PRECISION ELECTRIC ACCESSORY MOTORS

**BODINE MOTORS ARE BUILT TO LAST**

RESIST VIBRATION

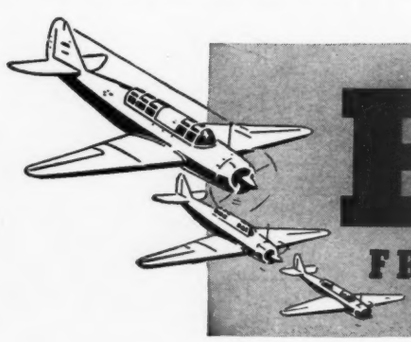
ENDURE TEMPERATURE CHANGES

LIGHT IN WEIGHT

**MEET AIR CORPS SPECIFICATIONS**

Whether they are used on death-dealing warplanes or on the huge skyliners of a few years hence, aircraft accessory motors must meet the same requirements. They must be carefully designed to make them extremely light in weight. They must be thoroughly dependable, whether they are used continuously or intermittently. They must be safe for operation near gasoline fumes. They must withstand high temperatures. Continuous vibration must not affect them.

Bodine electric aircraft motors easily meet these requirements. High standards of precision are constantly maintained by accurate machining from tested high quality materials, and by constant testing and inspection of all parts during manufacture. While Bodine's present production is entirely devoted to making motors for the war effort, their 35 years of engineering experience are available to you in developing your designs for post-war use. Bodine Electric Company, 2274 W. Ohio St., Chicago, Ill.



**BODINE**

**FRACTIONAL HORSEPOWER MOTORS**

# Synthetic Coatings Protect Engine Parts

**New use of Resistoflex PVA solution at Packard puts resilient covering on wire baskets to maintain undamaged surfaces in degreasing and transportation.**

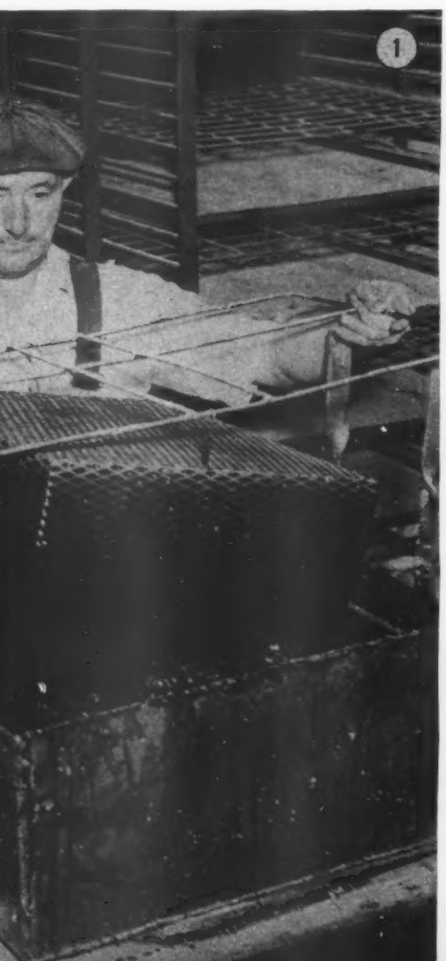
TRUE MAINTENANCE BEGINS IN the factory, even before parts have been assembled to make the completed unit, whether it be an engine, propeller, airframe or accessory. Such care is particularly necessary in aircraft engine plants where highly polished parts can easily be damaged by improper handling.

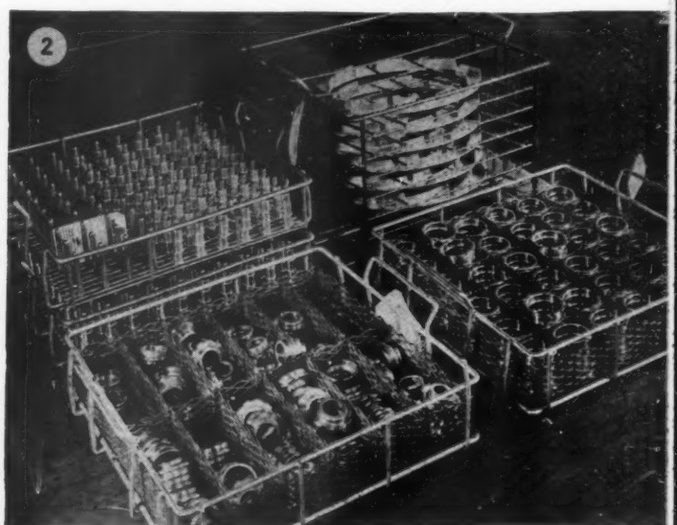
Proper handling today is being enhanced by ingenious use of the newer resins, some of which have been found to be superior to strategic materials which they replace. In the manufacture of Rolls-Royce *Merlin XX* aircraft engines, for example, Packard engineers have used such a synthetic as covering for metal baskets, trays and racks used in parts handling.

The baskets, varying in size and type, are ordinary steel rod, with metal inserts. In the adaptation for engine parts-handling, the containers are first degreased and dipped twice in a Resistoflex PVA solution especially formulated for coating metal, then run through a low temperature oven to speedy drying. The resulting coat has certain characteristics of rubber—flexibility, elasticity and resiliency—but is not affected by gasoline, oils and most organic solvents including chlorinated hydrocarbons. It requires no vulcanization and contains no sulphur which might tarnish highly polished metals, an important factor in uses such as that at Packard.

The material which Packard has put to this new use on a large scale consists mainly of a modified polyvinyl alcohol compound which, until processed, is neither thermoplastic nor thermosetting. With proper handling it can be molded to any shape or extruded into hose or other finished products using processes which are similar to those of the rubber and plastics industries.

*FIG. 1. Preparing a wire parts-handling basket at the Packard plant producing Rolls-Royce "Merlin" engines. The baskets are purchased uncoated and dipped twice in Resistoflex, a modified polyvinyl alcohol resin solution and then run through a drying oven. The resulting coating is a tough abrasion and solvent resisting film which is, however, resilient so that it will not harm highly polished engine parts. FIG. 2. Almost any type or size of basket or tray can be coated with the synthetic. In the background at the left is a rack with spindle-type holders and at the right a rack type for larger engine parts, while the carriers in the foreground have different types of basket inserts. The trays can be used both for holding parts during degreasing and for transportation. The synthetic resin—the same material used for aircraft fuel and hydraulic lines—is unaffected by the solvents used in degreasing. FIG. 3. The Resistoflex coated containers can also be used for storage. An added advantage lies in the fact that the parts can be easily identified, even on the bottom of the stack.*



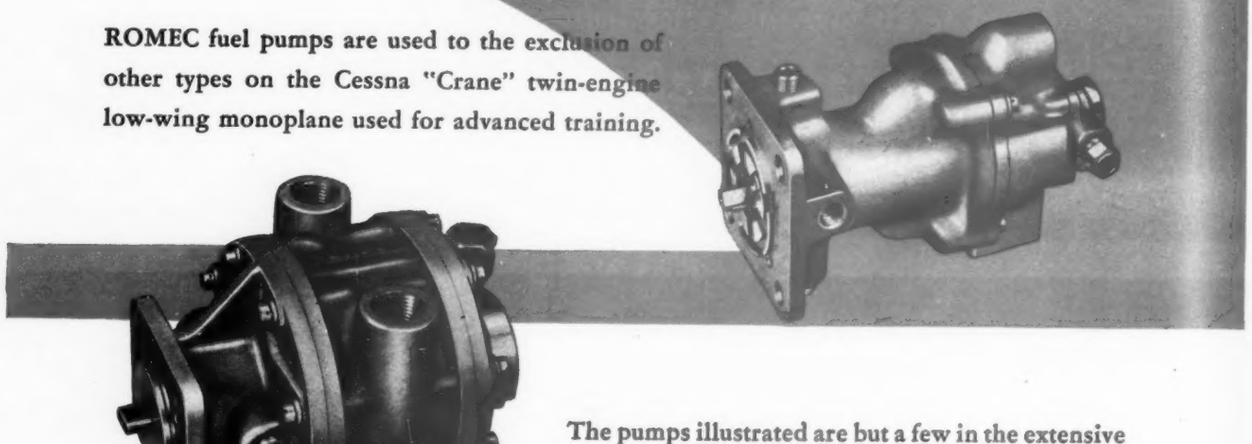



BUY WAR BONDS

# High Performance TRAINERS..

## Call for High Performance PUMPS!

ROMEC fuel pumps are used to the exclusion of other types on the Cessna "Crane" twin-engine low-wing monoplane used for advanced training.



The pumps illustrated are but a few in the extensive line of ROMEC aircraft pumps for fuel, air, oil, and ethylene glycol. Pumps famous for their fine flight performance.

We pledge our unlimited cooperation in this all-out emergency to help you attain the correct answer to every pump problem. Simply write us full details.

As the crew cannot perform better than their hearts, so the planes and motors cannot perform better than their pumps.

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PUMP COMPANY

ELYRIA, OHIO, U. S. A.

Manufacturers of ENGINE-DRIVEN PUMPS, ELECTRIC MOTOR-DRIVEN PUMPS, and HAND-OPERATED FUEL PUMPS

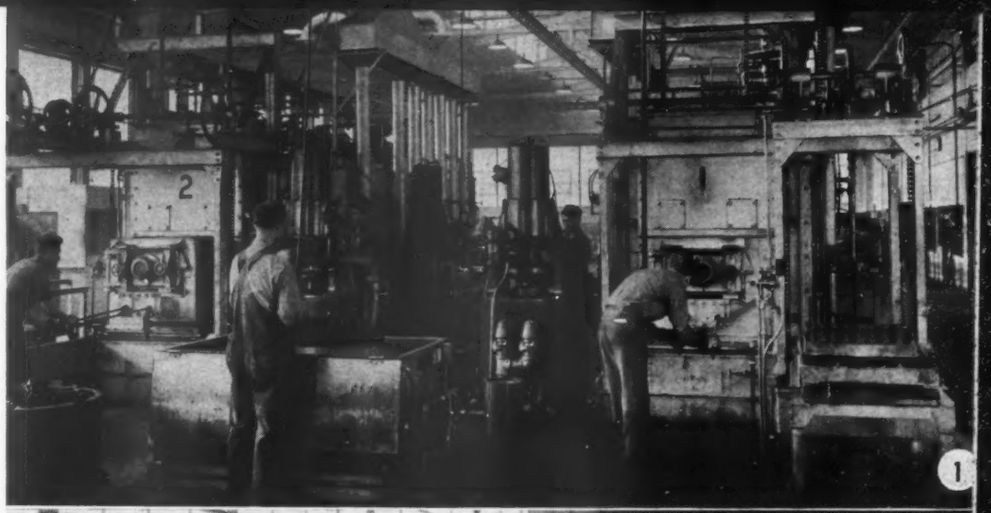


*FIG. 1. Discharge end of the Holcroft hardening furnaces. The seven vertical vent pipes ending below the exhaust hood connect with the radiant tubes in which combustion takes place. Also shown are the three presses for dies in which large parts are clamped before quenching. Tank in foreground is for degreasing parts upon removal from quench. . . . FIG. 2. Ross furnace in which aluminum cylinder heads and blocks are given two-hour stress relief treatment as they are carried through on a slowly moving conveyor. Special wheeled rack for block and heads is shown at left.*

# Heat-Treating Aircraft Engine Parts

**Application of production line technique to custom jobs illustrated at Packard plant producing Rolls-Royce engines.**

WHILE HEAT-TREATING is often much of a "custom job," large scale manufacture of Rolls-Royce aircraft engines for both British and American planes has brought the production line technique to this department of Packard Motor Car Company's plant. Volume of heat-treat work is such that the department occupies a separate building, adjacent to that in which the heat-treated parts are machined.

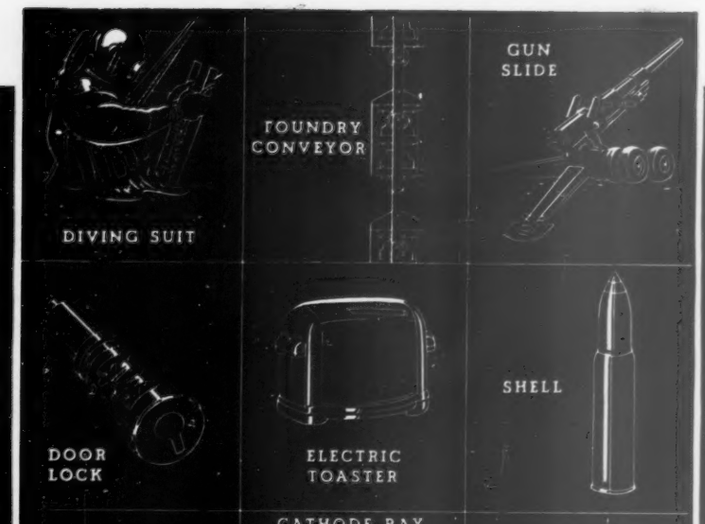
The unit is equipped to do carburizing, hardening, drawing, nitriding, cleaning and inspection of steel parts, as well as to perform stress relief on some aluminum and steel parts. All work is done on the ground-level floor, although some of the equipment rests on foundations located in the basement, which also contains cooling tanks and piping.

Parts to be heat-treated are received on trucks, some of which are designed to carry racks for particular parts. Although most of the parts are already partly machined, great care is exercised to avoid marring or scratching which might lead to rejections or even to service failures. Most parts undergo grinding or other machine work after heat-treatment but are, nevertheless, handled much as if they were in finished form and ready for assembly.

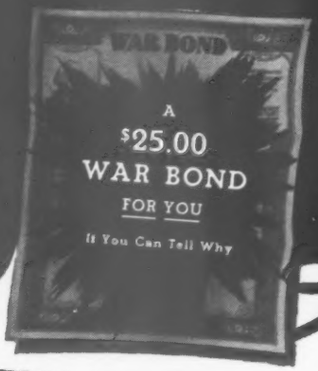
Most of the parts are first delivered to the carburizing and hardening end of the heat-treat department, where there is a degreasing tank where all parts to be heat-treated are removed. Many parts, chiefly forgings made from AMS 6250 and 6290 steels (equivalent to SAE 3312 and 4615 respectively), require carburizing which is done in ten Leeds and Northrup furnaces arranged in two rows of five each. Parts to be carburized are placed in wire trays and baskets for loading into automatically controlled furnaces by means of a one-ton bridge crane equipped with floor controls.

Carburizing is done at 1,700 deg. F. for one to eight hours, depending on the thickness of case required. About 0.060 in. of effective case is produced in eight hours. Carbon, supplied by natural gas containing about 75 percent methane, is constantly circulated by a fan in the bottom of each furnace. Flow of the gas is regulated as required for the particular charge and amounts to from 5 to 20 cu. ft. per hr. Subsequent to this carburizing parts are, in many cases, transferred to an adjacent brick-lined chamber where they remain in a natural gas atmosphere at a temperature of 700 deg. F. for two to six hours. Parts which are not to be hardened all over, and which are returned to the machining department for removal of the case where it is not wanted, are allowed to cool slowly to 1,200-1,500 deg. F., and the baskets are set on the floor for cooling to room temperature. Parts carburized range from $\frac{1}{2}$-in. plugs up to gears of 13-in. diameter.

Most of the parts to be hardened, whether previously carburized or not, are put through one of two Holcroft continuous furnaces, which are heated by interior radiant tubes using gas fuel, hence the products of combustion do not come into contact with the parts undergoing heat-treatment. The furnaces are divided into five zones, each equipped with its own temperature controlling device. The atmosphere of both furnaces




"dag"




**HERE ARE THE RULES**

Acheson Colloids Corporation will give a $25.00 War Bond to each of the 5 people who submit complete and accurate answers together with the 5 best letters on the question, "Why is **'dag'** colloidal graphite important in the manufacture and/or use of the twelve products pictured here?" (1) State business connections (no one in the graphite field or their families will be eligible). (2) All entries must be legible. (3) All entries must state the publication in which the advertisement was seen. (4) Entries must be postmarked not later than January 15, 1943. (5) In case of ties, duplicate awards will be made. (6) Entries become the property of the Acheson Colloids Corp. (7) The verdict of the judges will be final.

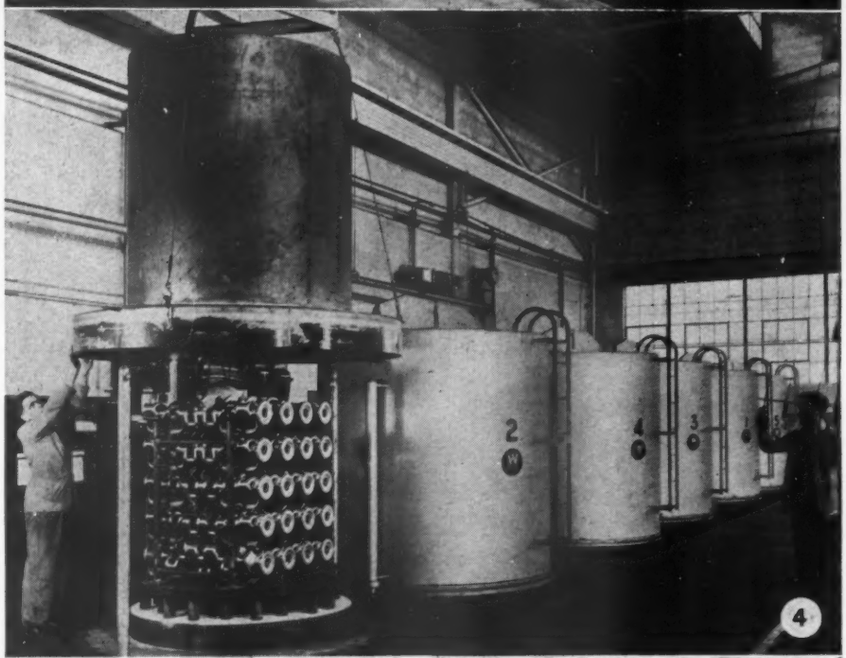
*Write*
for NEW BULLETIN 422H
on the use of "dag"
Colloidal Graphite as
a Parting Compound

dag COLLOIDAL PRODUCTS

dag COLLOIDAL PRODUCTS

ACHESON COLLOIDS CORPORATION, Port Huron, Mich.

*FIG. 3. Some of the Lindberg drawing furnaces, one of which is being charged by use of overhead crane with floor controls. Automatic control panels are visible in background, against the wall. At extreme left is Wheelabrator for blasting parts after heat treatment, and to the right of the furnaces is a quench tank. . . . FIG. 4. Battery of Westinghouse nitriding furnaces showing, at left, a rack filled with crankshafts ready for treatment. One of the two bells for enclosing the charge is being lowered into place. . . . FIG. 5. Two of the small Lindberg tilting hearth furnaces used for certain small parts. At right is quench tank equipped with fixtures which move and rotate parts through the quench while holding them against warpage. . . . FIG. 6. Group of machines on which forgings are given hardness tests after heat-treatment. Grinder at left is employed to remove a portion of the case on parts which have been carburized as one step in determining thickness of the case applied. Note baskets and sturdy wheeled dollies for transporting parts from one section of heat-treat department to another.*



is automatically controlled and contains a mixture of carbon-monoxide, carbon-dioxide, and water vapor fed from the generator containing charcoal. The $CO_2$ content is maintained at about 2 percent since, if the percentage is too high, there is a tendency to reduce hardness of the parts treated and, if too low, some carburizing of the machine surfaces takes place.

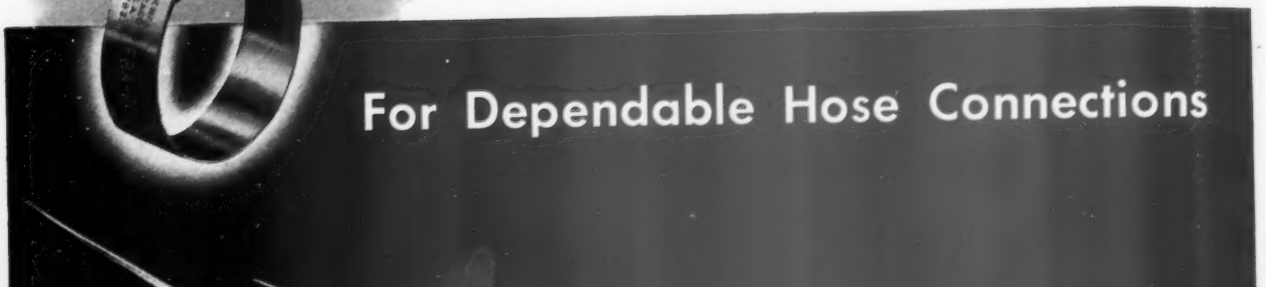
The hardening furnaces are equipped with rails on which trays containing the parts to be heat-treated are advanced to the furnace in 16 pushes. At each push, the charging door opens automatically to receive the next tray and that at the opposite end is discharged on to a Lowerator which drops it into quenching oil, the temperature of which is held at about 110 deg. F. The rate of passing through the furnace is adjusted to correspond with the part being put through and is so set that parts which have been carburized obtain a temperature of about 1,475 deg. F. Batches which have not been carburized are heated to 1,500 to 1,525 deg. F. Large parts which might warp during quenching are removed with tongs from a side door near the end of the furnace and placed in a die-press, arranged for air clamping. Three such presses are provided to serve both furnaces.

In addition to the continuous hardening furnaces there are two Lindberg tilting hearth furnaces for special jobs on small parts requiring 1,850 deg. F. These furnaces are used for parts such as valve seats which require special heat-treatment and rods which require special handling in a quenching fixture to avoid warpage. In one such case, rods

(*Turn to page* 327)

# Wittek *AVIATION* Hose Clamps

## For Dependable Hose Connections



Streaking through the skies, squadrons of swift fighter planes are in the fight and doing our nation proud—establishing brilliant records as a daily routine of our Army Pilots. Wittek Aviation Hose Clamps are helping to keep many of them flying with dependable hose connections.

Since the early days of modern aviation Wittek has served the industry and today this reputation is serving the Nation well. Wittek Aviation Hose Clamps are made of quality materials and by experienced craftsmen. They are used by the outstanding builders of military aircraft and meet existing Army and Navy specifications. Wittek Manufacturing Co., 4305-15 West 24th Place, Chicago.

**WITTEK** *Aviation* **HOSE CLAMPS**

# REVIEW OF PATENTS

## By A. HARRY CROWELL, *Patent Lawyer*

THE FOLLOWING are digests of the more significant recent patents on aviation developments announced by the U. S. Patent Office. Mr. Crowell will be glad to furnish AVIATION readers with preliminary information without charge respecting their patent and trademark matters. Address inquiries to AVIATION, 330 W. 42nd St., New York, N. Y. Complete printed copies of any of the patents listed are obtainable at a cost of 10¢ each directly from the U. S. Patent Office at Washington.

**Air Rotor,** 2,297,815, G. W. Tidd, assignor to Autogiro Company of America. The invention relates to the balancing of rotors of unsymmetrical form having dissymmetry of rotational drag. It is especially applicable to the balancing of counterweighted single-blade rotors of the propulsive airscrew type commonly used on aircraft.

**Radio Landing Control System,** 2,297,822, G. H. Wintermute and G. L. Davis, assignors to Washington Institute of Technology, Inc. A plurality of fixed stations are disposed about a landing area. Mobile transmitting means are used in the establishment of the radiated fields of the landing system. The relation of the mobile means and the fixed stations is such that the transmitting means may be properly positioned with respect to any desired or necessary direction of landing.

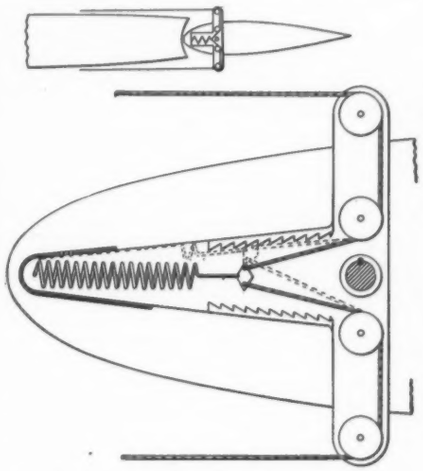
**Rate of Climb Indicator,** 2,297,873, S. Cerstvik, assignor to Bendix Aviation Corporation. A pressure vane type of instrument, wherein a differential between the pressures outside and inside of the instrument, established by a change of one of the pressures is utilized to indicate the rate of climb or descent, particularly adapted for use in small aircraft.

**Aircraft Control,** 2,298,523, S. H. Webster, assignor to Bendix Aviation Corporation. An appliance to start the wheels rotating prior to landing, so that their speed is nearly proportional to the landing speed of the plane. The device also provides for gradual deceleration of the wheels, after first contact with the ground. The object is to save wear on the tires.

**Transmission,** 2,298,645, H. D. Jackes, Jr., assignor to Wright Aeronautical Corporation. A clutching system by which the drive ratio in a gear train may be altered while the gear train is under load, particularly for two-speed supercharger drives as used on aircraft engines.

**Lubrication System,** 2,298,646, W. G. Ovens, assignor to Wright Aeronautical Corporation. A pressure control system in a force feed lubricating system by which determinate pressure may be maintained at that end of the system most remote from the pump while disposing the relief valve itself close to the pump.

**Tension Compensating Device,** 2,298,611, H. H. Bruderlin, assignor to Douglas Aircraft Company, Inc. The device is for compensating cable tension, especially for



steering control systems of aircraft. The device functions only while the tension in the cables is equalized or is of the same order of magnitude, and which is automatically overcome, or locked out, on operation of the control system.

**Broaching Machine,** 2,298,647, P. F. Rossman, assignor to Curtiss-Wright Corporation. A machine tool of the generating broach type, particularly a propeller blade generating machine which utilizes the principles of broaching and which is capable of finish cutting a propeller blade to final form quickly and accurately.

**Combination Landing Gear and Aircraft Gun Recoil Mechanism,** 2,299,227, C. C. Goetz. The guns subject to sliding along or movement about carriages on recoil are engaged with the landing gear as a recoil mechanism, the standard recoil devices of the gun carriages being thereby eliminated.

**Shock Absorbing Strut for Airplanes,** 2,299,613, E. W. Cleveland and E. R. Warner, assignors to the Cleveland Pneumatic Tool Company. A nose or tail wheel support including an oleo shock strut enabling free castoring action during ground contact and having automatic correct landing position obtaining means when off the ground.

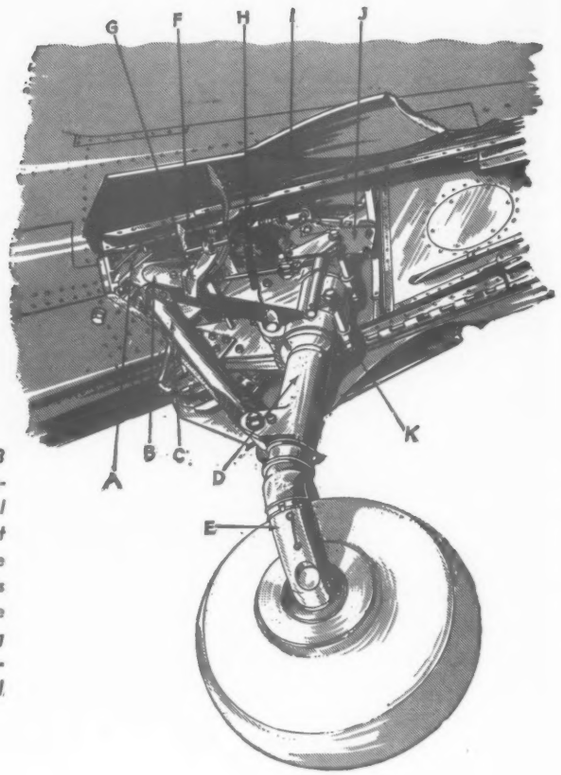
**Valve Assembly,** 2,299,615, G. T. Downey, assignor to Aero Supply Manufacturing Co., Inc. An improved rockable valve structure and improved sealing means so that a valve of this type may be used for regulating the flow of gasoline to an engine. The valve structure may be readily removed without complete disassembly of the valve assembly.

**Propeller Control Mechanism,** 2,299,635, C. I. MacNeil and R. T. Zwack, assignors to Bendix Aviation Corporation. An improvement on the Caldwell patent 1,893,612 type, adding to the Caldwell system the concept of automatic governor adjustment. A propeller pitch control mechanism involving a hydraulic unit and control valve.

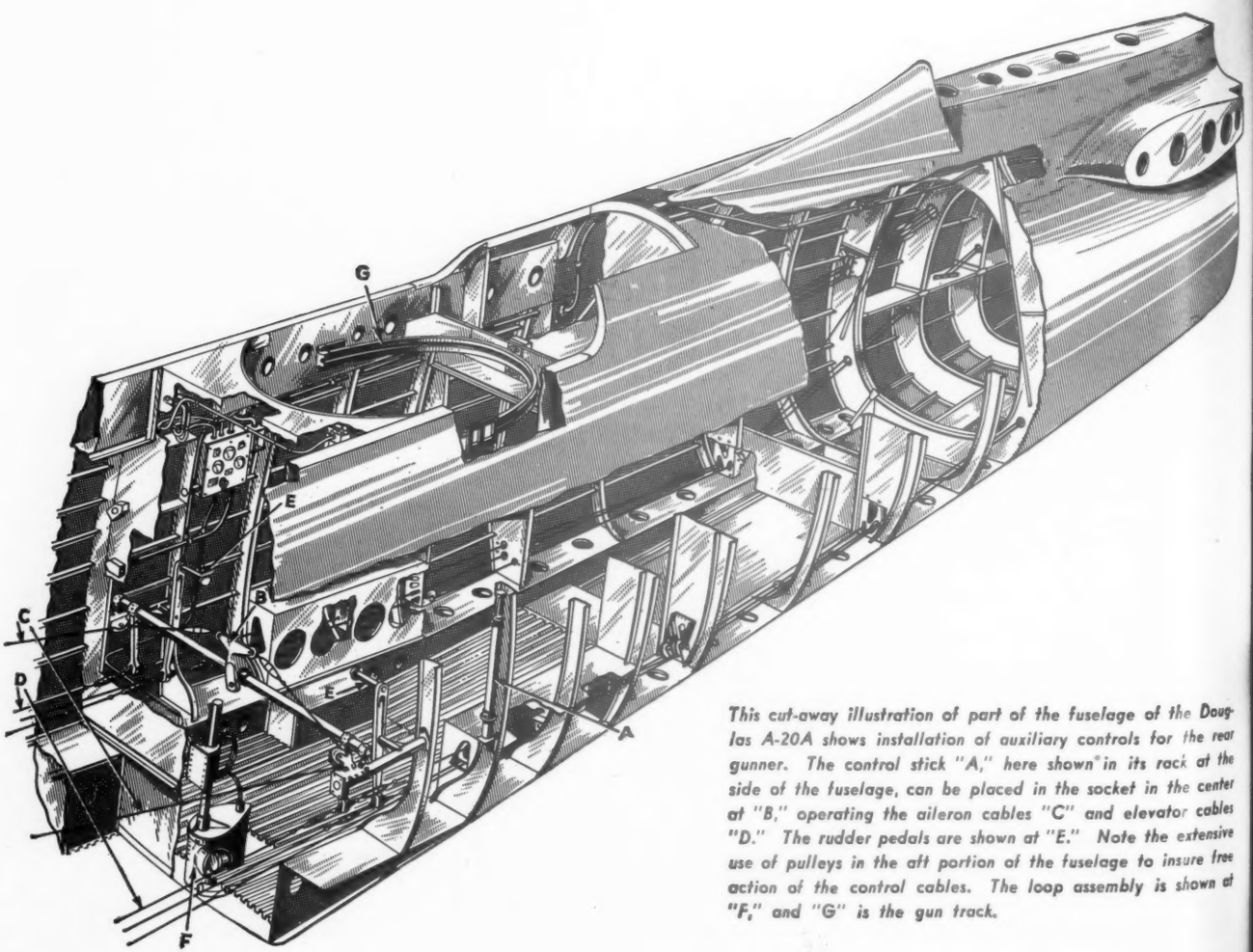
URGE STANDARDS ADOPTION

*Typical posters being distributed to members by National Aircraft Standards Committee in its industry-wide drive for adoption of uniform standards. It is the committee's hope that displaying such posters on bulletin boards will not only promote standardization among aircraft manufacturers, but will encourage individuals in various plants to submit similar sketches for distribution throughout the industry.* *(See article page 165.)*

# SKETCH BOOK of Design Detail




*The retractable tail wheel of the Republic P-43 "Lancer" is shown at right. Operated by a hydraulic motor forward and above the unit, the wheel swings back and up into the fuselage, pivoting at "A." "B" is the yoke of the gear, "C" is the brace tube, "D" is the shock strut and "E" is the fork. As the wheel retracts, the roller "F" drops over the angle "G" and the spring "H" pulls the fairing "I" into place below the wheel. "J" is the steering rod connection for the wheel and "K" is tail wheel swivel lock pin actuating mechanism.*




*This cut-away illustration of part of the fuselage of the Douglas A-20A shows installation of auxiliary controls for the rear gunner. The control stick "A," here shown in its rack at the side of the fuselage, can be placed in the socket in the center at "B," operating the aileron cables "C" and elevator cables "D." The rudder pedals are shown at "E." Note the extensive use of pulleys in the aft portion of the fuselage to insure free action of the control cables. The loop assembly is shown at "F," and "G" is the gun track.*

# Making the Enemy DIE

## FOR HIS COUNTRY

## VICKERS

## HYDROMOTIVE CONTROLS

Soldiers of the U. S. Army are now given this maxim: "It is commonly supposed that the primary duty of a soldier is to die for his country. This is not true. It is his duty to make the enemy die for his."

The spirit of aggressiveness which this reveals should be heartening to every American, and all Americans will want to do everything they can to make the enemy "die for his country" in this war of survival.

Vickers Incorporated is contributing to this effort on many fronts. Vickers Hydromotive Controls on our war planes have helped compel many an enemy into this sort of heroism. These high pressure oil hydraulic controls are dependable, accurate, easy to operate, easily adjusted, insensitive to vibration and shock . . . reliable no matter how tough the going.

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# AEROQUIP SELF-SEALING COUPLINGS

**AEROQUIP SELF-SEALING COUPLINGS ALLOW DISCONNECTION OF LIQUID CARRYING LINES WITHOUT LOSS OF FLUID OR TRAPPING OF AIR UPON RECONNECTION. . . . .**

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LOS ANGELES, CALIF.

EASTERN REPRESENTATIVE:
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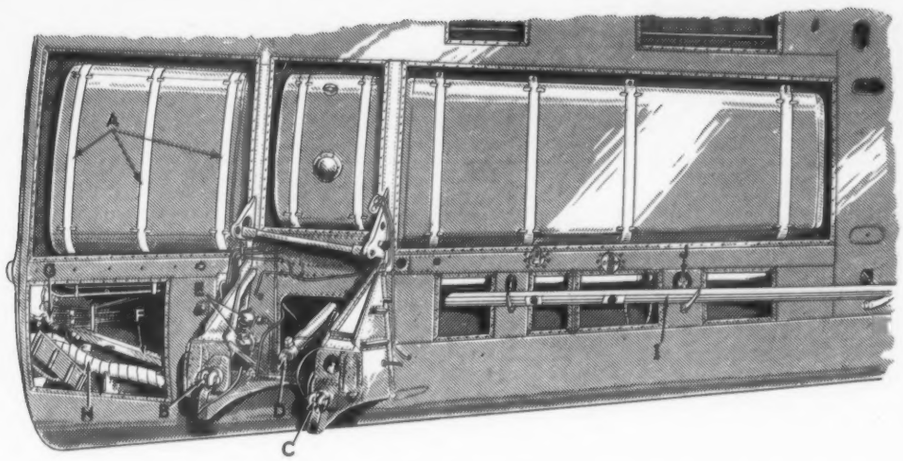
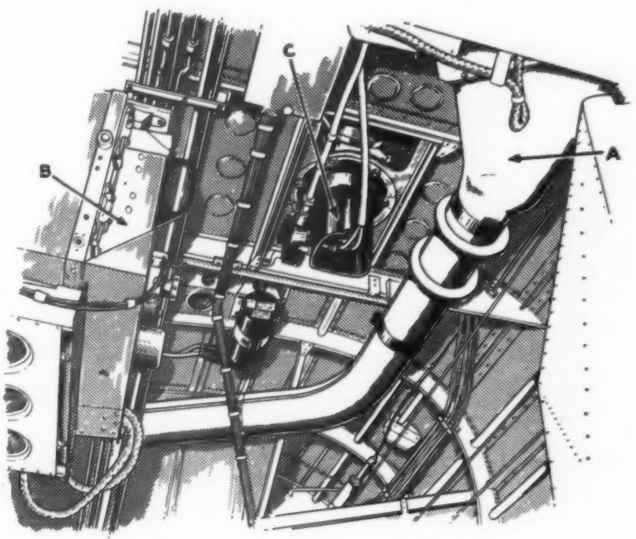
HAGERSTOWN, MD.

AEROQUIP CORPORATION
JACKSON, MICHIGAN, U. S. A.

# AEROQUIP HOSE LINE

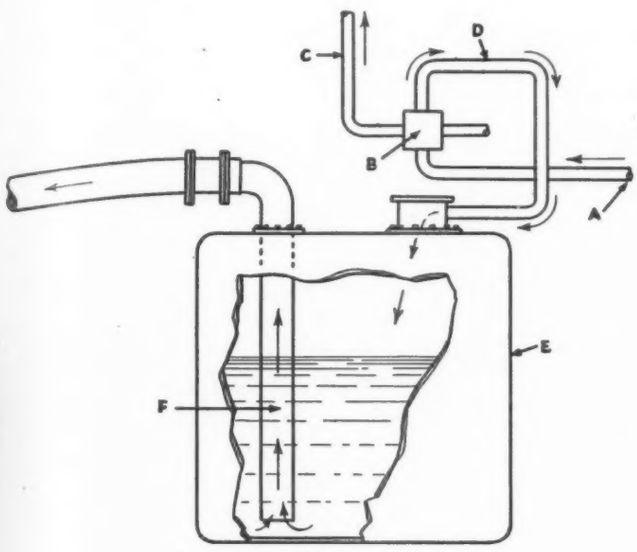


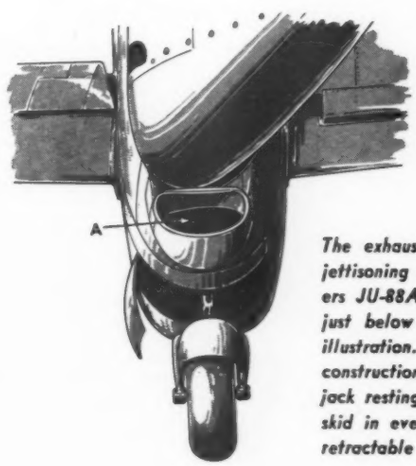

*Wing tanks of the Junkers JU-88 are located outboard of the center section, there being three to a side with capacity of 195 gal. per wing. The tanks are held in place by canvas straps "A." Metal cover plates (removed for the drawing) are screwed onto the lower surface of the wing. The landing gear hinge points are at "B" and "C," and "D" is the retracting strut. Fuel pumps are housed inside the nacelle at "E." The conduit "F," an aluminum case with removable cover, contains all electric wiring for the wing. Hydraulic and fuel lines enter the wing at "G." The leading edge of the wing is heated for de-icing; the asbestos-covered conduit "H" taking part of the heated air to the cabin. The venetian blind diving brake "I," shown in extended position, is operated hydraulically by the unit "J."*



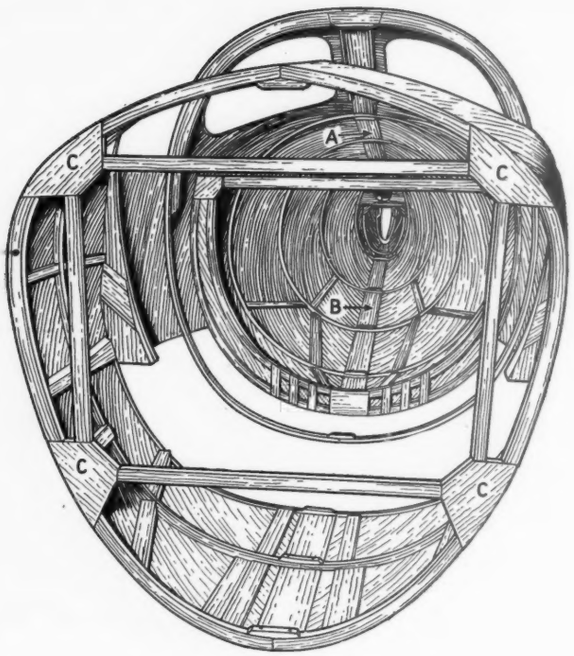

*Looking aft inside the fuselage, the fuel jettisoning pipe "A" is supported from the roof, crossing to the opposite side behind the radio "B." The directional loop is in the center at "C."*

*As shown in the diagrammatic drawing below, the Junkers JU-88A-1 has a unique jettisoning system for the 300 gal. fuselage tank, an auxiliary placed in the bomb bay for long-range operations. When this tank is used the plane carries two 550 lb. bombs in external racks. Jettisoning utilizes compressed air from the supercharger blower. The intake from both blowers is at "A," the air passing through a solenoid valve "B." The pipe "C" is a vent to the atmosphere, while the pipe "D" leads to the fuel tank "E." To jettison the fuel, the pilot closes the solenoid valve, sending the air into the tank, forcing the fuel out through the pipe "F" which leads out through the fuselage to the tail.*



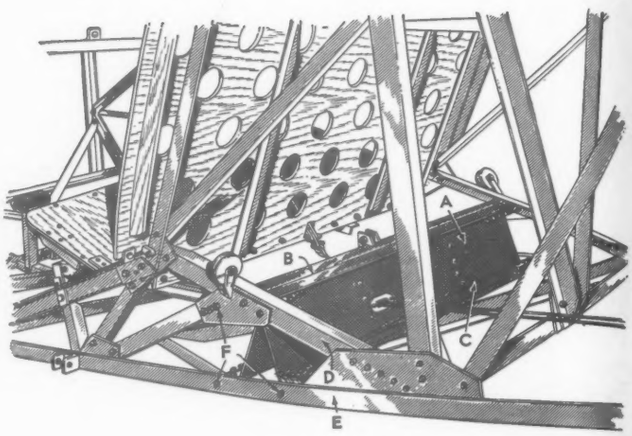



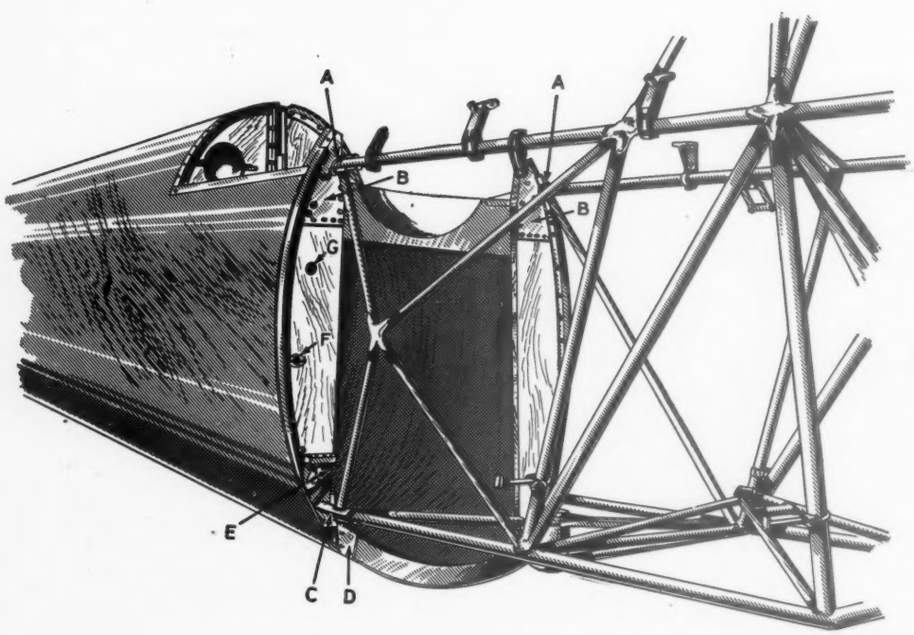

*The exhaust vent for the fuel jettisoning system of the Junkers JU-88A-1 is shown at "A" just below the rudder in this illustration. The pipe is of heavy construction and serves as a jack resting point or as a tail skid in event of failure of the retractable tail wheel.*




*Simplicity of the Engineering Research Corporation's "Ercoupe" fuselage design is shown in the sketch at left. The seam lines "A" and "B" join the two integrally molded halves. The gusset plates "C" complete the simple joint for both fire wall and engine mount structural members. The halves of the fuselage are molded as one unit from the fire wo back to the tail section.*

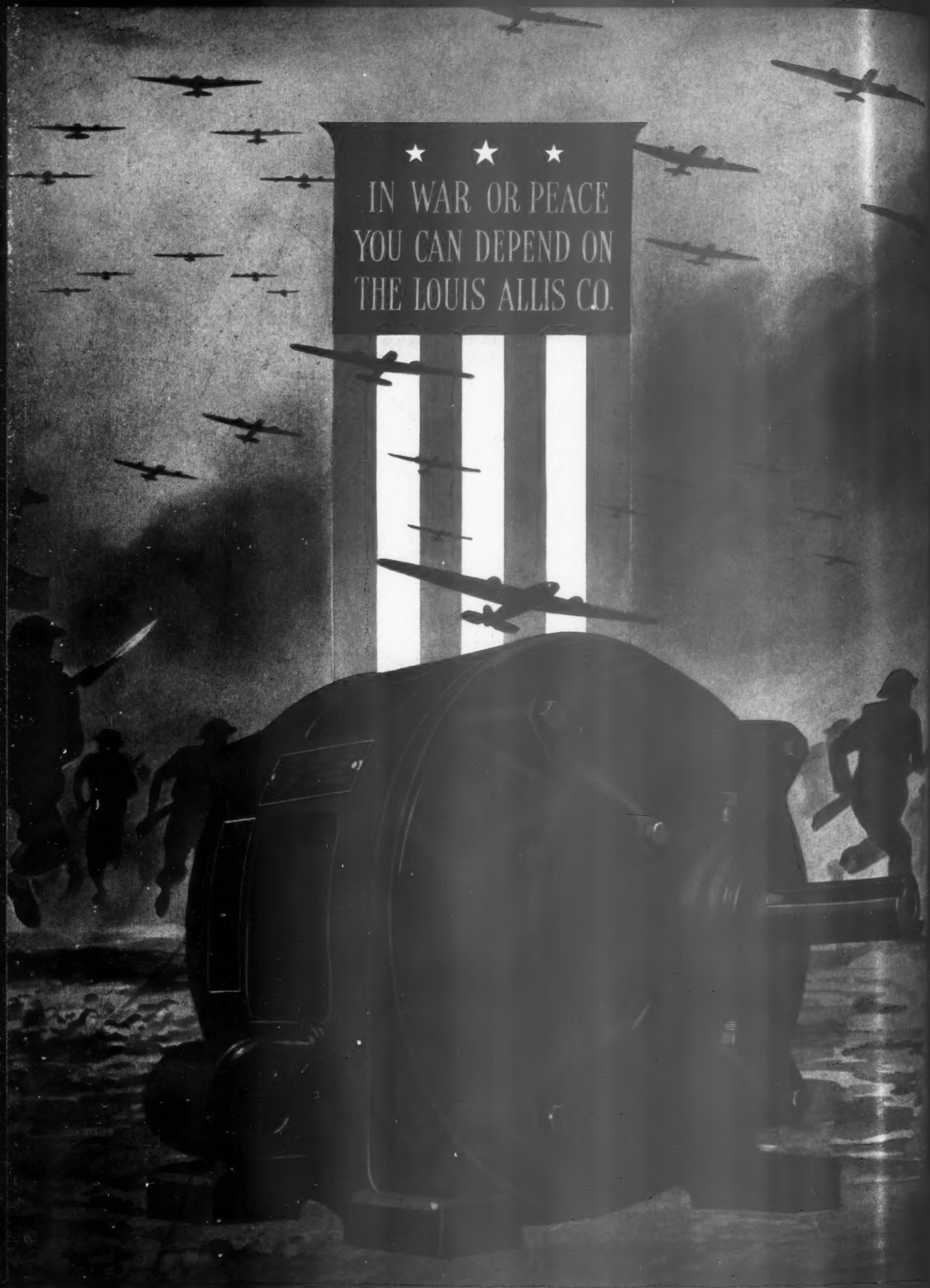
*The landing gear truss attachment of the General Aircraft "Skyfarer" is shown at right. The truss is at "A" and is built up of two inclined flat plates making the sides and joined at the top between two aluminum alloy angle sections "B." Each plate is reinforced at the bottom by angle sections "C" riveted along the edge. The fuselage angle section frame members "D" and "E" afford support at the end of the truss. The landing gear strut is attached by bolts at three points "F."*




*The method of attaching the plywood aft-section of the fuselage to the welded tubular mid-section of the North American trainer is shown at left. Two bolts at points "A" on each side of the fuselage make the connection at the top. Metal plates "B" pick up the shear load in the web and take it out through the upper fitting. At the lower connection "C" the tube flattens out and two bolts are used, running vertically through the tube. "D" is a metal plate serving the same load-carrying function as the plate "B" at top connection. "E" is a pulley bracket and holes "F" and "G" are holes for control cables. (Also see AVIATION's Sketch Book for August and September, 1942.)*

THE LOUIS ALLIS CO., MILWAUKEE, WIS.




THE LOUIS ALLIS CO., MILWAUKEE, WIS.

# Machining Aluminum

## Cuts, Speeds, and Feeds When Machining Aluminum Alloys

| (See Note) | Rough Machining | | | Finish Machining | | |
|---|---|---|---|---|---|---|
| | Max. Cut Inches | Speed (fpm) | Feed, Inches | Cut, Inches | Speed (fpm) | Feed, Inches |
| LATHE TURNING | | | | | | |
| Type I castings, not heat-treated | 0.25 (a) | 500 to 900 | 0.020 to 0.030 | 0.002 to 0.010 | Maximum | 0.002 to 0.010 |
| All others | 0.19 (a) | 400 to 800 | 0.007 to 0.020 | 0.002 to 0.010 | 600 to 900 | 0.002 to 0.010 |
| MILLING | | | | | | |
| Type I castings, not heat-treated | 0.25 | 400 to 600 (b)<br>500 to 700 (c)<br>Maximum (d) | 5 to 15 (e) | 0.010 to 0.020 | 500 to 700 (b)<br>500 to 700 (c)<br>Maximum (d) | 10 to 25 (e) |
| Type I castings, heat-treated<br>Type II castings<br>Types I and II wrought alloys, heat-treated | 0.25 | 400 to 600 (b)<br>500 to 700 (c)<br>Maximum (d) | 4 to 10 (e) | 0.010 to 0.020 | 500 to 700 (b)<br>500 to 700 (c)<br>Maximum (d) | 5 to 15 (e) |
| Type III alloys | 0.25 | 300 to 500 (b) | 3 to 8 (e) | 0.010 to 0.020 | 500 to 700 (b) | 4 to 10 (e) |
| BORING | | | | | | |
| Light duty (1 to 2 inch) | 0.09 (a) | Maximum (f) | 0.010 to 0.020 | 0.010 to 0.020 (a) | Maximum (f) | 0.001 to 0.005 |
| Medium to heavy duty | 0.25 (a) | 600 to 1000 | 0.007 to 0.015 | 0.010 to 0.020 (a) | 600 to 1000 | 0.001 to 0.003 |
| SHAPING | | | | | | |
| Heavy duty (36 inch) | 0.25 | Maximum (g) | 0.010 to 0.030 | 0.005 to 0.010 | Maximum (g) | 0.100 to 0.150 |
| PLANING | 0.38 | Maximum (h) | 0.025 to 0.100 | 0.005 to 0.015 | Maximum (h) | 0.050 to 0.375 |

NOTE: See table below for explanation of Type numbers listed above in first column.

(a) Cut measured on radius.
(b) For carbon steel tools.
(c) For high-speed steel tools.
(d) For cemented carbide tools.
(e) Travel of work.
(f) Peripheral speed of tool is maximum of most machines.
(g) Travel of ram.
(h) Speed of table.

## Types of Commercial Aluminum Alloys With Respect to Machinability

| Type* | Alcoa Alloys | | | |
|---|---|---|---|---|
| | Casting Alloys | | Wrought Alloys | |
| | Non Heat-Treated | Heat-Treated (a) | Non Heat-Treated | Heat-Treated (a) |
| Type I | 173 | 220 (b) | 11S | .... |
| | C113 | 122 | .... | .... |
| | 645 | .... | .... | .... |
| | B113 | .... | .... | .... |
| Type II | 112 | D195 | 61S | 56S |
| | 216 | 142 | 53S | .... |
| | A214 | 195 | A51S | .... |
| | 109 | B195 | 17S | .... |
| | 12 | .... | .... | .... |
| | 214 | .... | .... | .... |
| | 212 | .... | .... | .... |
| | B214 | .... | .... | .... |
| Type III | 172 | 355 | 25S | 4S |
| | A108 | A355 | 70S | 52S |
| | 108 | 356 | 18S | 3S |
| | 356 | A132 (c) | 14S | .... |
| | 43 | .... | 24S | .... |
| | .... | .... | 32S (c) | .... |

NOTES: *Type I alloys have best machining characteristics.
(a) Heat-treated as usually sold, namely a solution treatment followed by aging at room or elevated temperature.
(b) Alloy 220 is not aged.
(c) Alloy cuts freely, but wear on tools may be excessive unless they are tipped with cemented carbide.

(*Continued on page* 185)

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# Machining Aluminum

## General Characteristics of Tools for Aluminum

Although the machining properties of the various aluminum alloys differ, the principal differences between aluminum and most other metals with respect to the tools required are characterized as follows and should be carefully observed:

1. Grind more top and side rake on the cutting tools than is common for machining steel.
2. Keep cutting edges sharp and free of burred or wire edges.
3. Maintain smooth, bright tool surfaces free from scratches.

### TOOL MATERIALS

Tools of plain high-carbon steels frequently perform satisfactorily when machining aluminum and most of its alloys. Under conditions in which the cutting speeds are necessarily low, they may be the most economical and this is particularly true for small diameter drills. For quantity production work, tools made from high-speed steels have largely replaced the carbon steel tools, but in many instances, tools tipped with cemented carbides have proved far superior to high-speed steel tools. Tools of this last type are especially suited for the machining of aluminum alloys of high silicon content; in fact some of these alloys cannot be machined successfully under production conditions without it. The cemented carbide tipped tools, when ground to proper rake angles, produce excellent machined surfaces and remain sharp for long periods of time without regrinding; consequently these tools are economical for high rate production. The use of cemented carbide tools is, of course, restricted to operations in which the work is free from vibration and irregularities in the cut.

### TOOL SHAPES

In general, the larger rake angles are employed for finishing tools and for the aluminum alloys that are not free cutting; this includes the softer materials which require tools with exceptionally acute and keen cutting edges. On the other hand, rake angles in the lower range are used for roughing cuts and for machining the alloys that have free-cutting characteristics. Tools similar to those used for machining steel may often be employed successfully.

Top rake generally varies from 20 to 50 deg. Very finely finished surfaces may be produced with tools having a top rake angle in the higher end of the range, but, obviously, such a tool can be used only in a machine that is sturdy, free from vibration, and which has no lost motion in the feeding mechanism. For some operations it may be necessary to use a top rake smaller than indicated by the above range, but a negative rake should never be used.

Side rake is important in machining aluminum and its alloys as this produces a slicing action which is especially effective in parting the cutting from the stock. A side rake of from 10 to 20 deg. assists materially in the cutting action of the tool. Planer and shaper tools may have a considerable amount of side rake; finishing tools have been ground with a side rake as high as 60 deg. in order to take full advantage of the free-cutting characteristics of aluminum.

The clearance should be about 8 to 10 deg. The clearance must be carried around the side of the tool which advances into the work. This angle is important. If too small, the side of the tool will rub against the work and generate heat. If too large, the tool may tend to dig into the work or chatter.

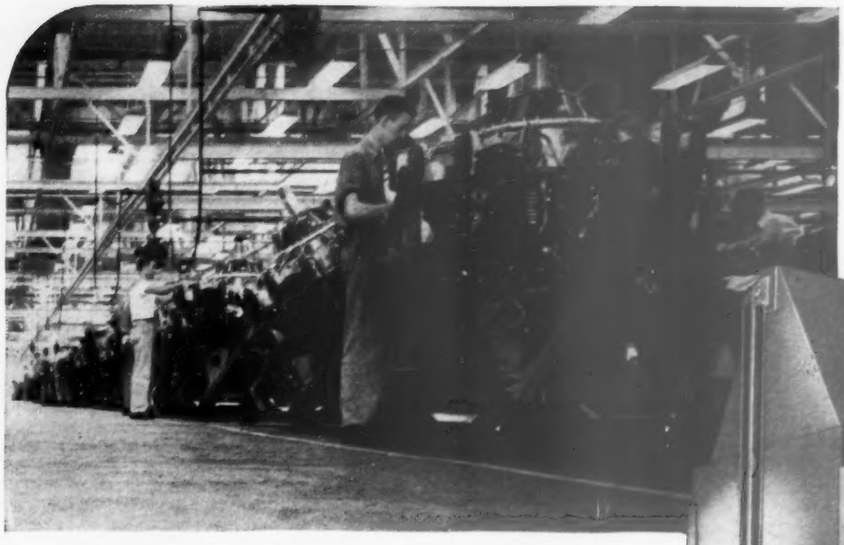
In all cases it is essential that the cutting edges be keen, smooth, and free from grinding wheel scratches, burrs, or wire edges. Too much emphasis cannot be given to tool finish, because on it depends, to a large extent, the success of machining aluminum and its alloys. Keen edges are best obtained by finish grinding on a fine or very fine abrasive wheel, then hand stoning with a fine or very fine oilstone, or lapping, taking care that neither the angles nor the contour of the cutting edges are appreciably modified during the finishing operations. Where possible, cemented carbide tools should be diamond lapped.

## Mechanical Finishing of Aluminum Alloys

| | Roughing | | | Greasing or Oiling | Buffing | Coloring | Finish* Grinding |
|---|---|---|---|---|---|---|---|
| | Solid Wheel | Cloth Belt | Sewed Muslin | | | | |
| Abrasive | $Al_2O_3$ or SiC | $Al_2O_3$ | $Al_2O_3$ | Turkish Emery | Tripoli | Fine Lime or Soft Silica | SiC |
| Carrier | Solid Wheel | Cloth Belt | Sewed Muslin Buffs | Sewed Muslin Buffs | Pocketed Muslin Buffs | Open Muslin or Flannel | Solid Wheel |
| Grit | 16 to 100 | 46 to 300 | 46 to 80 | 120 to 240 | | | 30 to 40 |
| Bond | Phenolic Resin | Glue | Glue | Glue | | | Vitrified |
| Hardness | Medium | | Medium | Medium | Soft | Very Soft | Soft |
| Peripheral Speed of Wheel, feet per minute | 6,000 to 12,000 | 3,000 | 6,000 | 6,000 | 7,000 to 8,000 | 3,000 to 4,000 | 6,000 to 7,000 |
| Lubricant | Dry or Grease | Grease or Kerosene | Grease | Grease | Grease | | Soluble Oil 1 to 35 or 40 |

* Mechanical finish applied to castings—to be preceded by machining.

From: "Machining Alcoa Aluminum," Aluminum Company of America



★ *Photograph courtesy Wright Aeronautical Corp.*

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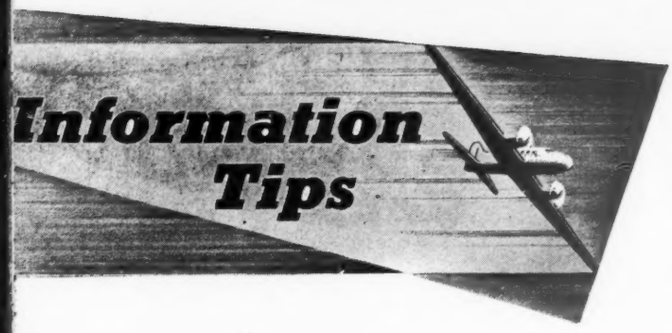


# Keep UP-TO-DATE On Developments

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**Heat-treating** ..... ....1
Brochure describing furnaces for heat-treating such aircraft parts as fuselages, struts, engine mounts, oil lines, propellers and other parts. The Surface Combustion Co., Toledo, Ohio.

**Low Temperature Welding** .....2
A 36-page, illustrated booklet covering the *Castolin Eutectic Low Temperature Welding Process* giving data which can be used as a guide for welding problems of all kinds. Published by Eutectic Welding Alloys, Inc., 40 Worth St., New York, N. Y.

**Electrostatic Heating**.....3
A profusely illustrated 22-page booklet titled *Thermex High Frequency Heating* describes industrial applications of the technique, and describes how it can be applied to non-metallic materials. Data sheet for inquiries seeking specific information and recommendations is included. The Girdler Corp., Thermex Division, Louisville, Ky.

**Electric Connectors** .....4
Dealing with two leading types used in aircraft production, the condensed catalog supplement of Cannon Electric Development Co., Los Angeles, Calif., also gives information on connectors for radio microphones, sound equipment, power heavy-duty control circuits, public address systems and geophysical research, electronic low-level circuits and small power applications.

**Abrasive Equipment** ..... .....5
A new illustrated manual covering care of the Wheelabrator unit; general maintenance hints; electrical instruction; ventilation requirements; proper use of abrasive; operation of Wheelabrator Tumblasts. The American Foundry Equipment Co., 555 S. Byrkit St., Mishawaka, Ind. offers manual.

**Copper Plating**.....6
A six-page leaflet designed to improve selective hardening and deep-drawing of steel describes the *Unichrome Alkaline Copper Plating Process* in deep-drawing of steel parts where a ductile, adherent coating of copper is required to act as a lubricant between work and the drawing dies. Bulletin No. 49, United Chromium, Inc., 51 E. 42nd St., New York, N. Y.

**Micarta Data** .....7
Information on design and selection of Micarta, light, strong and resistant industrial plastic, is contained in 36-page *Booklet B-3184* offered by Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

**Barrel Pump**.....8
*Engineering Bulletin No. 425*, issued by Trabon Engineering Corp., Cleveland, describes company's new electro-hydraulic pump for pumping oils or greases directly from original containers. Pump operates from any electric outlet.

**Bonding Ring** ..... .....9
Bulletin on its new bonding ring is available from Cannon Electric Development Co., Los Angeles. Ring is used almost exclusively at present in bonding shielded radio and instrument circuits. May be used with either flexible conduit coupling nuts or cable clamps.

**Drawing Problems** .....10
*Drafting for Victory* is title of new series of folders, prepared with cooperation of aircraft companies, offered by Eagle Pencil Co., 703 E. 13th St., New York. Folders deal with mechanical drawing problems for basic instruction in aircraft drafting.

**Tooling Set-Ups** .....11
Details of six different set-ups for Universal Slotmaster showing ways machine can be used to save tooling cost and time, are presented in new edition of four-page brochure offered by Experimental Tool & Die Co., 12605 Greiner Ave., Detroit.

**Alloy Chart** ..... .12
Analyses, physical characteristics, and applications of 19 different stainless steel, Monel, and nickel alloys are included on compact chart available from the Cooper Alloy Foundry Co., 200 Bloy St., Hillside, N. J. Also given are handy cross references of designations and type numbers of institutes, societies, United States Navy, and others.

**Grinding Wheels** ..... .....13
Twenty-six page photo-and-diagram illustrated data booklet, *Grinding Wheels, Their Construction and Selection*, has been published by Mid-West Abrasive Co., 1960 E. Milwaukee Ave., Detroit. Described are various types of grinding wheels, honing, and superfinishing stones, and there are tables and charts detailing specifications, wheel speeds, spindle diameters, and wheel weights.

**Flexible Shaft Machine** ..... 14
Numerous flexible shaft devices, their many uses and specific applications, are covered in *Catalog No. 30*, newly issued by Foredom Electric Co., 27 Park Place, New York. Kits, machines, grinders, and accessories are covered in well illustrated ten-page publication.

**Bearing Lubrication**..... 15
SKF Industries, Inc., Philadelphia, has published *A Guide to Better Bearing Lubrication*. Thirty-two pages are filled with designs, formulas and graphs explaining highly technical functions, phases, and practical problems of correct ball and roller-bearing lubrication.

**Flexible Aircraft Controls** .....16
Handbook of instructions on how to install and maintain Simmonds-Corsey flexible aircraft controls has been issued by Simmonds-Aerocessories, Inc., 10 Rockefeller Plaza, New York, aircraft accessory and precision instrument maker. Special feature of handbook is two-page drawing of typical control layout.

**Process Control**.....17
The Brown Instrument Co., Wayne and Roberts Aves., Philadelphia, has recently published a 64-page booklet titled *The Technique of Precision Control in Industrial Processes*. (Booklet 80-1) Information on precision measurement, fundamentals of control, types, and typical applications are offered. There are numerous schematic diagrams and illustrations of systems and apparatus.

**Alloys** ..... 18

Revised *Duronze Manual*, published by Bridgeport Brass Co., Bridgeport, Conn., has just come from press. Eighty-page booklet contains technical data and applications for five different Duronze alloys supplied in sheet, rock, wire, tubing, and ingot. Includes numerous compositions, specifications, curves and tables.

**Bolts, Screws, Rivets** ..... 19

Comprehensive new 228-page catalog has been prepared by National Screw & Manufacturing Co., Cleveland. A 50-page aviation products section gives full information on company's bolts, nuts, screws, plotters, etc., used in aircraft industry.

**Metal Parts Washers** ..... 20

Various types of Detrex washers for use with alkali cleaning compounds, petroleum spirits, and emulsion cleaners are pictured and described in new 24-page booklet announced by Detroit Rex Products Co., 13005 Hillview Ave., Detroit. Special aircraft industry adaptions are given.

**Radio Motors** ..... 21

*Catalog No. 100*, issued by Carter Motor Co., 1608 Milwaukee Ave., Chicago, illustrates and describes dynamotors, converters, and hand generators for radio communication. Special attention is drawn to small, light PM dynamotor, 100-watt model of which weighs but 4¾ lb.

**Calendar** ..... 22

"Elephant size dates" are feature of *New Engineer's 1943 Weekly Calendar* prepared by Frederick Post Co., Box 803, Chicago. Over-all size is 15¾x24½ in. Technical data of value to engineers are included.

**Forge Welder** ..... 23

Temp-A-Trol, recently announced machine stated to offer new approach to resistance welding, is described in *Bulletin No. 301* released by Progressive Welder Co., 3050 E. Outer Drive, Detroit. Combined automatically controlled spot welding and heat-treating of alloy steels is special feature of unit. Bulletin shows line drawings of thermocouple electrodes, typical welds made with unit, comparisons of grain structure, diagram of automatic phase-shift heat control, etc.

**Flexible Drill Shaft** ..... 24

*Bulletins 421, 422 and 427*, available from the Stow Manufacturing Co., Binghamton, N. Y., describe flexible extension for electric drill, enabling work around corners, in close quarters, and other places where regular drill cannot reach. Drill adapter, park angle head, and collet angle head are likewise detailed.

**Aero Engine Overhaul** ..... 25

Equipment and procedure for improved fast method of degreasing and decarbonizing aircraft and other engine parts for overhaul is described in 16-page booklet recently issued by Turco Products, Inc., of Los Angeles and Chicago. Titled *Turco Procedure for Aircraft Engine Overhaul*, it includes many diagrams and photographs.

# LATEST MACHINE TOOLS

## Small Gear Finisher ..... 26

With great new demand for small gears (¼ to 4-in. pitch diameter) for use in navigation instruments, gun sight mechanisms, bomb sights, etc., **National Broach & Machine Co.**, Detroit, has developed Red Ring (Model GCL-3" gear finisher, special shaving machine to speed critical operation of finishing such small instrument gears. Company reports unit is capable of finishing-job of 8 to 48 sec. per gear, handling gears with diametral pitches of from 20 to 48 and even finer. Model is essentially bench-type machine, but it is also furnished with base containing ample coolant system and electric-control panel. Unit being small, battery of machines may be mounted on bench with central coolant system. Model incorporates principle of rotary crossed axes shaving, using gashed helical cutter which drives work gear as it cuts. Cutter rotates only in one direction, and because there is no intermediate gear train between cutter and work, possible inaccuracies from such cause are avoided. In addition to cutter spindle drive, functional parts consist of two slides (vertical with cutter head and horizontal carrying work) both of which are provided automatic lubrication by pump mounted in column. For various sizes of work gears, initial vertical adjustment of cutter-head slide is made by means of screw and calibrated hand wheel, and indicator provides constant check of size of finished product. Precision bearings of cutter spindle may be adjusted without dismantling cutter head. Three speeds of cutter spindle and of table

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The National Screw & Mfg. Co., Cleveland, Ohio
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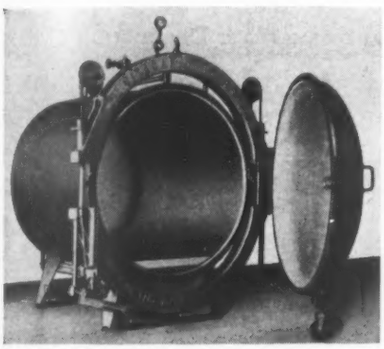
Pawtucket Screw Co., Pawtucket, R.I.
Pheoll Manufacturing Co., Chicago, Ill.
Russell, Burdsall & Ward Bolt & Nut Co., Port Chester, N.Y.
Scovill Manufacturing Co., Waterbury, Conn.
Shakeproof Inc., Chicago, Ill.
The Southington Hardware Mfg. Co., Southington, Conn.
Whitney Screw Corp., Nashua, N.H.

reciprocation are available. Specifications: Cutter head, spindle speed, 200, 350, and 500 rpm.; work table, length of travel (one stroke) 0 to ½ in.; strokes per cycle, 4, 6, or 8; table feed strokes per min., 10, 20, or 30.—AVIATION, *December*, 1942.

## Plywood-Plastic Curer . . . . . 27

Use of plywood being augmented in the aircraft industry, attention is drawn to Vitacap Chamber offered by **American Tire Machinery Co.**, 810 E. 61st St., Los Angeles, for curing laminated (hot form) plywood, plastics, and synthetics. Unit illustrated, 45-in. o.d. by 48-in. deep, is used in making of airplane parts. Maker reports availability of chambers in diameter dimensions of 45, 56, 75, and 90 in., and special materials may be secured for special custom jobs of other sizes. Positive seal, quick closing and locking doors are feature of units, which are built for 90-lb. working pressure. In addition to straight steam hook-up, chambers may be used for high-pressure, low-temperature curing through a combination air-steam installation. AVIATION, *December*, 1942.



## Drill & Bore Machine . . . . . 28

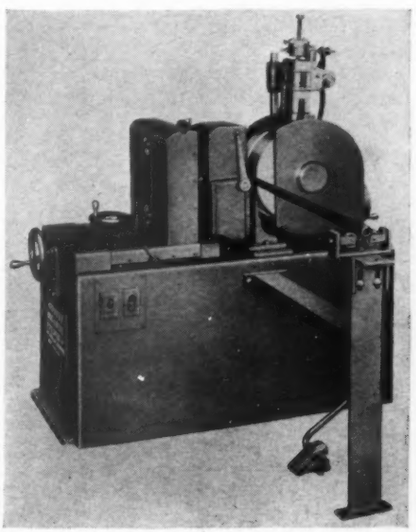
Model 445, new independent, two-spindle, deep hole drilling and boring machine, announced by **W. F. & John Barnes Co.**, Rockford, Ill., is designed to drill or bore two parts simultaneously in completely independent cycles. Supported by separate steadyrests, each workpiece is driven by independent headstocks. Tools are fed by independent hydraulically actuated slides. Normally, four-jaw, 15-in.-dia. chucks are furnished, but those of 24-in. dia. may be used. Screw adjustment on steadyrest rollers permits handling 5-in. to 16-in. o.d. work. Steadyrest tops are hinged to facilitate workpiece handling when loading and unloading. Hydraulic feed cylinders in base are actuated by two motor-driven hydraulic feed and traverse units. Specifications of machine, which may be completely controlled from each of four pushbutton stations, follow: Stroke 16 ft., swing 25-in. dia., length of part 15 ft. 8 in. max., tool size 5-in. dia., spindle centers 26-in. dia., spindle height from ways 20-in. dia., spindle hole 4¼-in. dia., and approximate weight 83,000 lb.—AVIATION, *December*, 1942.

## Cutout-Coil Welder . . . . . 29

Low open-circuit value of 42 is feature of "Bumble Bee" portable, transformer-type AC welding machine offered by **Wilson Welder & Metals Co.**, 60 E. 42nd St., New York. Two 42-v. primary coils are used, with magnetic contactor in circuit of one primary. However, one primary automatically cuts out when machine is idle, only being thrown into circuit when electrode contacts work. When operator draws arc, open circuit potential of two primaries (84-85 v.) enables him to establish arc quickly and begin welding. On pulling out arc at completion of welding (most of which ranges between 32 and 40 v.) arc voltage rises. But on reaching 45 v., one primary cuts out. Power factor correction in this 18-in. wide unit is provided by built-in capacitors on all four sizes—300, 500, 750, and 1,000 amp.—which likewise cut out when machine is idle. Welder has dual voltage connections for either 220 or 440 v., cutout coil assures thermal overload protection, and handwheel control offers current adjustments throughout NEMA range.—AVIATION, *December*, 1942.

## Cylindrical Finisher . . . . . 30

Wide variety of applications is featured by the "OD" (outside diameter) cylindrical finishing machine introduced by **Hammond Machinery Builders**, 1638 Douglas Ave., Kalamazoo, Mich. Arrangement of machine with special wheel polishing member is illustrated.



Machine may also be set up with back stand idler pulley and patented segment face contact wheel permitting use of surface-coated abrasive belts,

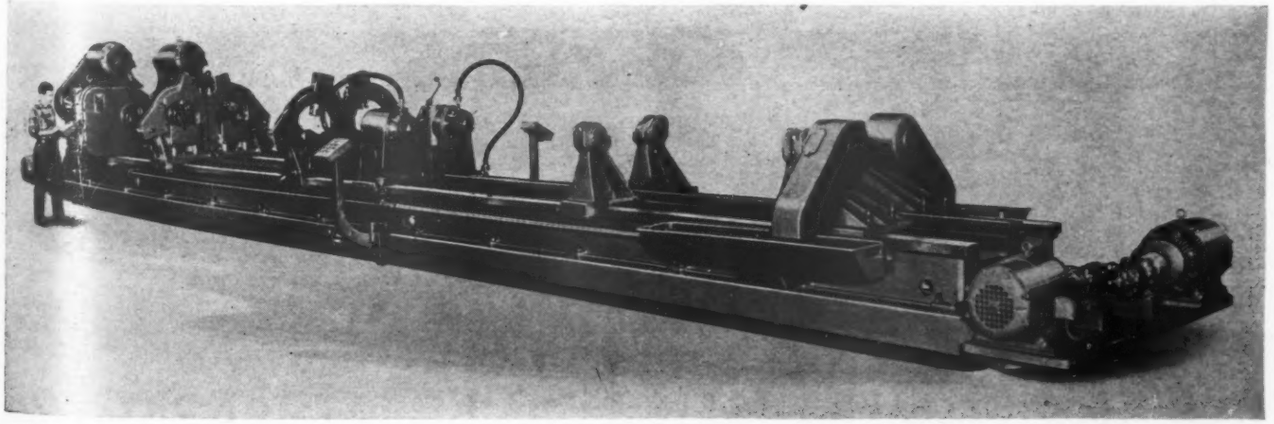


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*Illustration shows careful water pressure testing of an important aircraft aluminum casting*

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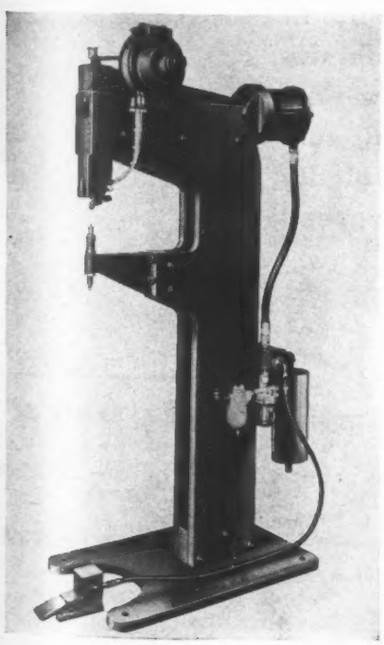
running over face of wheel and to back stand for finishing and polishing many additional materials and shapes of articles. New abrasive belt method is said to effect striking savings while increasing production. Unit is designed with range of feed of 9 to 50 ft. per min. for 1-in. dia., forward or reverse, permitting good production by even "green" operators. There is simple adjustment of work support to wheel for items of varying diameters. Work support may be firm's standard or one specially built for customer's requirements. — AVIATION, *December*, 1942.

## Turret Lathe . . . . . 31

A new floor-type turret lathe, designed for rapid production on close tolerances of small chucking or bar work, is being introduced by the **South Bend Lathe Works**, Department X5, South Bend, Ind. Second operation work can also be handled efficiently, it is said. The lathe has a 10-in. swing over the bed or saddle swings, 1⅜-in. hole through the headstock spindle and 1-in. collet capacity. It is equipped with both compound rest cross slide and a handlever cross slide, which are interchangeable. Quick change gear box supplies 48 longitudinal power feeds for the universal carriage, 48 power cross feeds for the compound rest cross slide, and 48 thread cutting speeds, 4 to 224 per inch. There are twelve spindle speeds ranging from 50 to 1,357 rpm. —AVIATION, December, 1942.

## Riveting Machine . . . . . 32

To expedite flush riveting in aircraft production, the **Tomkins-Johnson Co.**, Jackson, Mich., has developed the Rivitor, air-powered riveting unit with automatic feed and setting mechanism. Air pressure, supplied by cylinder, is applied and stepped up via a toggle. Machine is designed with capacity for ¼-in. dia. by ¾-in.-long rivets. Other features: Vertical adjustment of lower tooling without disturbing upper-lower tooling alignment, also adjustable setting tools. Common variations in thickness of materials riveted is cared for automatically, while manual adjustments are provided for major variations.—AVIATION, *December*, 1942.



## Tapping Machines . . . . . 33

Line of high-production precision tapping machines — including both light-duty (Series LTM) and heavy-duty (Series HTM) types—has been


RYERSON

Specialized skill and experience built up in 100 years of steel-service to American Industry — vast tonnages of steel which move steadily through ten great Ryerson plants into war production — are at aviation's command.

For example, recently eighty seven bombers were held up awaiting delivery of 2⅜" rounds of WD-X4130. A Ryerson Steel-Service man was called at his home on a Sunday evening. Within a matter of minutes, Ryerson stocks in ten cities were being checked. All were temporarily out of the desperately needed bars—all but one.

A shipment of 2⅜" WD-X4130 rounds was just arriving at one of the Ryerson plants. The car was immediately opened and the same evening the steel was on its way to the airplane builder. A production bottleneck was broken.

When steel is needed in a hurry —and it often *is*, under pressure of war production — *call Ryerson!* If the required steel is to be had anywhere, Ryerson can, and will supply it!

**JOSEPH T. RYERSON & SON, INC.**
Chicago, Milwaukee, St. Louis, Cincinnati, Detroit, Cleveland, Buffalo, Boston, Philadelphia, Jersey City

# Avoid Production Delays with

# MOULDED PLYWOOD Parts

Aft-Deck Skin for Large Cargo Ship.

**Plastic-Bonded Moulded PLYWOOD is ideal for many aircraft components. It has great strength, light weight, a smooth surface, can be moulded to practically any shape and may be reinforced for added rigidity. Inquiries from prime and subcontractors are invited. Our Engineering Staff will gladly recommend how Moulded PLYWOOD parts can help you speed your production.**

## *Saves Scarce Metals*

**Moulded PLYWOOD also stretches the available supply of critical materials. It saves scarce metals for use where only metal parts can safely be employed. Conserve and produce.**

## AVIATION ENGINEERING INC.

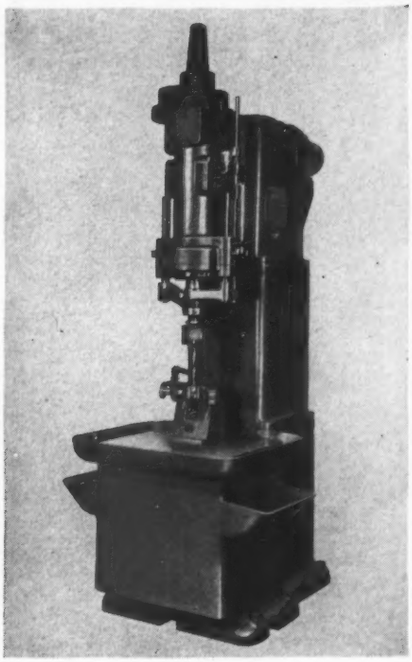
1392 BLASHFIELD, S.E. ATLANTA, GEORGIA

*T. Edward Moodie, Vice-President and Chief Engineer*

***Fabricators of:***

## PLASTIC BONDED PLYWOOD AIRCRAFT COMPONENTS

| | | | | | |
|---|---|---|---|---|---|
| Ailerons<br>Flaps | Rudders<br>Elevators | Bomb Bay Doors<br>Tail Cone Fairings | Landing Gear Doors<br>Fins | Nacelle Fairings<br>Entrance Doors | Super-Structures<br>Stabilizers, Etc. |



brought out by **Detroit Tap & Tool Co.**, 8432 Butler St., Detroit. Though designed as "specials," units lend themselves to variations, such as provision of single or multiple tapping heads, use for oil grooving, or long lead tapping. Inaccuracies resulting from lead-screw "wind-up" are avoided by use of lead screw which isn't required to drive tap. Lower end of tapping spindle is guided through entire stroke to assure accuracy, to avoid oversize hole tapping, and to permit accurate precise deep-hole tapping. Light-duty type taps up to $\frac{7}{8}$-in. dia. and 14 pitch in steel, maximum stroke of unit is 6 in., and three spindle speeds are provided ranging from 100 to 400 rpm. Heavy-duty machine has pick-off change gears between spindle and cone-drive-gear first reduction for changing of spindle speeds. Maximum stroke is 8 in., and holder allows taps to float horizontally only, without end play. Machine height of both units may be varied, and pedal, manual, or automatic-operating indexing fixtures are available. Intermediate capacity units, between light-duty (left above) and heavy (right), may be obtained.—AVIATION, *December*, 1942.

## Control-Cable Tester . . . . . 34

Drawbar dynamometer scale for testing control cables for stretch, guaranteed tensile strength, and ultimate breaking strength is announced by the **Kron Co.**, Bridgeport, Conn., maker of dial scales. Scale has 30,000-lb. capacity and dial chart has 25-lb. graduations. Both indicating point and dead needle remain in place to show ultimate testing strength following cable ruptures. Aircraft controls cables are attached to each other end-on-end and are roved back and forth between top and bottom sets of grooved sheaves. Control of hydraulic pressure, which produces cable tension, is at same end

of equipment as dynamometer scale, enabling rapid tests by one man. Shock absorber protects against back lash injury from cable rupture at full tension.—AVIATION, *December*, 1942.

## Production-Line Conveyors . . 35

Overhead conveyors, for use in any production involving a series of finishing operations and enabling careful control of speed and flow of material, are marketed by **Lamson Corporation**, Syracuse, N. Y., maker of material handling equipment and pneumatic tube systems. Conveyor keeps work ahead of every worker, there are no waits for parts.—AVIATION, *December*, 1942.


KOLD-HOLD

The "G.H.Q." for Latest Stratosphere Data

**For testing aircraft instruments and parts under conditions duplicating those found at higher altitudes make KOLD-HOLD your "General Headquarters" for stratosphere information. The KOLD-HOLD Stratosphere shown here, reproduces actual flying temperatures and pressures at will . . . controlled accurately when and where you need them.**

**In addition, visibility is always excellent . . . you can SEE the performance of instruments and devices with moving parts through the large Thermopane glass panel. Where requirements demand, stroboscopic beams may be directed through the panel to slow down the action and provide lubricant viscosity tests at the same time for charting and recording.**

**KOLD-HOLD's engineering service is ready to cooperate . . . send your requirements for complete recommendations.**

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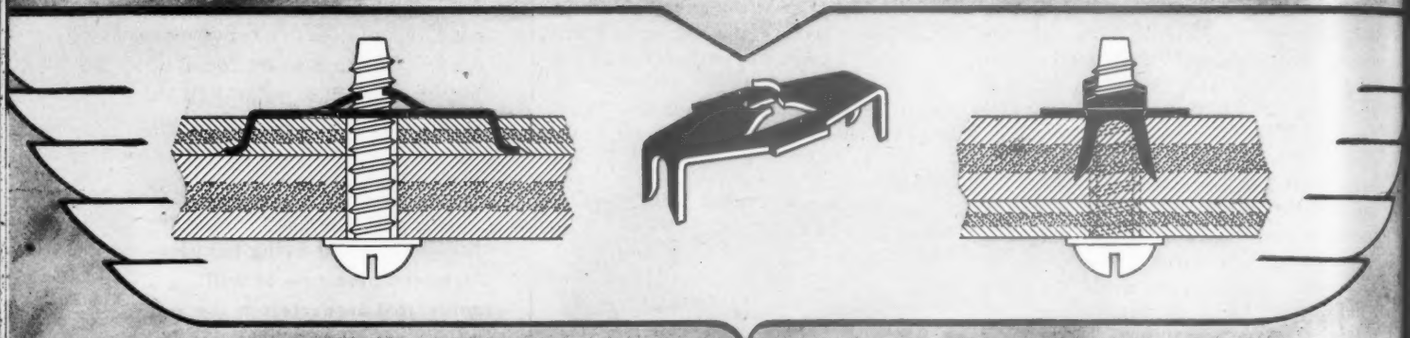
**LOS ANGELES—1015 W. Second—Mich. 4989**

KOLD-HOLD MANUFACTURING CO.
442 N. Grand Ave., LANSING, MICH., U.S.A.

# NOW.. Speed Nuts for Plywood



IN CANADA
Wallace Barnes Co., Ltd., Hamilton, Ontario
IN ENGLAND
Simmonds Aerocessories, Ltd., London

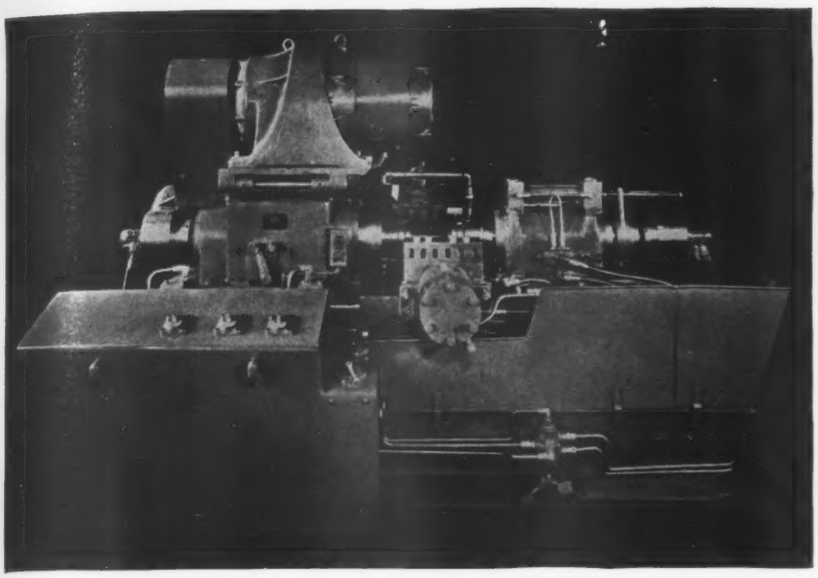
## Faster Application • Lighter in Weigh

● The need for the basic SPEED NUT principle of spring tension is eve greater in plywood. SPEED NUTS have a WIDE BEARING SURFAC which eliminates the need of a spanner washer beneath the nut.

This new SPEED NUT FOR PLYWOOD No. 6279, illustrated above is the only self-locking nut which can instantly be driven into anchored position. When driven into THIN plywood sections the attaching legs are "peened" over against a backing plate. When used with THICK plywood, the cam-like structure of the attaching legs forces them outward, as they are driven deeper into the wood. This gives the Speed Nut a firm spring tension grip on the wood. WEIGHING BUT 3½ LBS. PER THOUSAND, they are available for use on both AIR CORPS 530-8 and AIR CORPS 530-10 sheet metal screws. Write for bulletin 168 and samples.

**TINNERMAN PRODUCTS INC., 2070 Fulton Rd., Cleveland, O**

THE FASTEST THING IN FASTENINGS! Speed Nut Syste

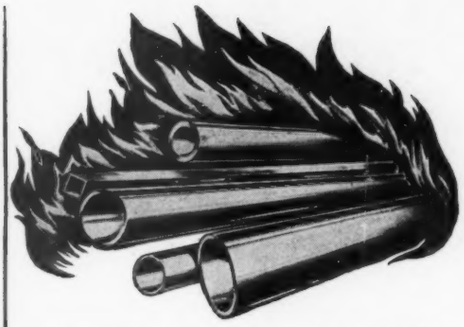


## Cylinder-Turning Lathe . . . . . 36

Heavy-duty, semi-automatic, cylinder-turning lathe, announced by **Sparks Machine Tool Corp.**, 32 Main St., Norwalk, Conn., accommodates six turning tools on front cross-slide for main body turning, using hydraulically operated cartridge tool holder, and "takes" another six tools on back slide, likewise worked automatically. Especially designed for turning of heavy airplane engine cylinders, machine has headstock with four selective speeds for work on different size cylinders, and motor has reduction gears for slow speeds when turning exceptionally hard cylinder material. Feeds are all controlled through metering valves convenient to operator. A treadle actuates holding equipment. Crated ready for shipment, lathe weighs approximately 13,800 lb.—AVIATION, *December,* 1942.

## Rapid Parts-Hardener . . . . . 37

Surface hardening of intricate-design metal parts at rapid rate is feature purpose of Tocco Junior induction-hardening machine offered by **Tocco Division, Ohio Crankshaft Co.**, 3800 Harvard Ave., Cleveland. Process is automatic once shafts are placed on fixture guiding them into electric inductor. Machine has indexing mechanism permitting regular interval stopping of shafts during fixture travel. Areas hardened are so well defined, says company, that remainder of shaft is not heated, thus minimizing distortion.—AVIATION, *December,* 1942.

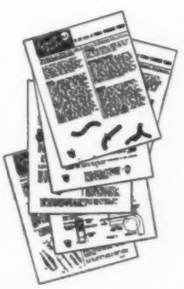


IF IT'S
**HEAT RESISTANCE**
YOU WANT

Exhaust collector rings, machine gun blast tubes and other products withstand corrosion and high heat, they have *longer service lives*—thanks to Carpenter Welded Stainless Tubing.

The *uniform wall thickness* of this tubing means that there are no thin spots to "burn out" first. And it is ductile, easy to fabricate—thus helping to speed the production of vital wartime equipment that must win battles against excessive heat. Then too, tubes are *natural design units.* Parts can often be finish-formed by merely swaging, tapering, expanding, etc.

If you have a wartime heat resistance problem that must be solved right now, take advantage of Carpenter's diversified experience in many plants where similar problems have been met and solved.



*FOR HELP in applying Welded Stainless Tubing, ask for our series of "Quick Facts" bulletins. They contain practical working information to help you with new design and fabricating problems. A note on your company letterhead will start a set of "Quick Facts" bulletins on the way to your desk.*

CARPENTER WELDED STAINLESS TUBING
*meets Army and Navy specifications; resists corrosion, heat, wear; is 100% hydrostatically tested.*

THE CARPENTER STEEL COMPANY
Welded Alloy Tube Division
Kenilworth, N. J.

Carpenter
WELDED
STAINLESS TUBING

# SHOP EQUIPMENT & ACCESSORIES

New Products

## Arc Control Stations. . . . . 38

**Wilson Welder & Metals Co.**, New York City, reports greater welding output per machine, better control by operator, and improved welds on thin gage metal through use of its Honey Bee arc control station. Stations are made in 75 and 150-amp. capacities. Two or more units (see photo) may be

hooked to single generator for operation of a like number of arcs simultaneously. Each operator may set unit to deliver definite current at arc for steady welding, or with hand switch he may vary current without breaking arc, enabling hot-arc start on cold metal with reduction of current as work warms up. When in series, each operator can regulate own current. And remote control of arc, at end of bead, permits improved quality of weld deposit at crater.—AVIATION, *December,* 1942.

## Crane-Truck Combination . . . 39

Designed to perform the functions of a load carrier crane and tractor, the new unit manufactured by the **Elwell-Parker Electric Co.**, Cleveland, Ohio, has an unobstructed platform 40-in. wide x 80-in. long x 25-in. high. Crane capacity is 2,000 lb. at 42 in. on the boom; tractor speed is 5 mph. It operates with two-wheel drive and four-wheel steer. Frame is made up of heavy section formed plates welded into one-piece structural unit embodying control dash.—AVIATION, *December,* 1942.

## Two-Way Radio . . . . . 40

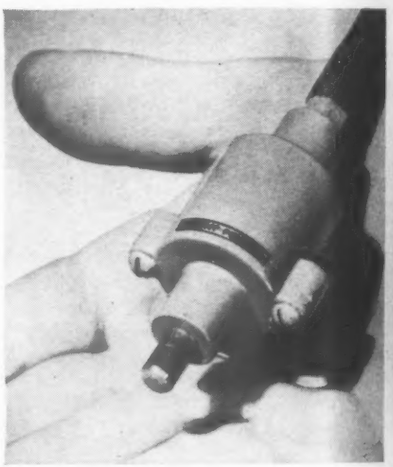
Two-way aircraft radio, consisting of three separate units for ease of installation, is announced by **Electronic Specialty Co.**, Los Angeles, manufacturer of Ranger radio line. Set includes Model 503 power supply operating from a plane's 12-v. storage battery. Model 110 receiver which has both 195-410 kc. band and spot frequency pre-tuned to 3105 kc., and Model 206 10.5-w. output transmitter operating on 3105 and 6210 kc. Units are connected by flexible cables permitting considerable flexibility in installation. In addition to "spot" frequency, receiver is equipped with two-way interphone circuit for communication between pilot and observer. Three units combined weight 19 lb. 2 oz.—AVIATION, *December,* 1942.

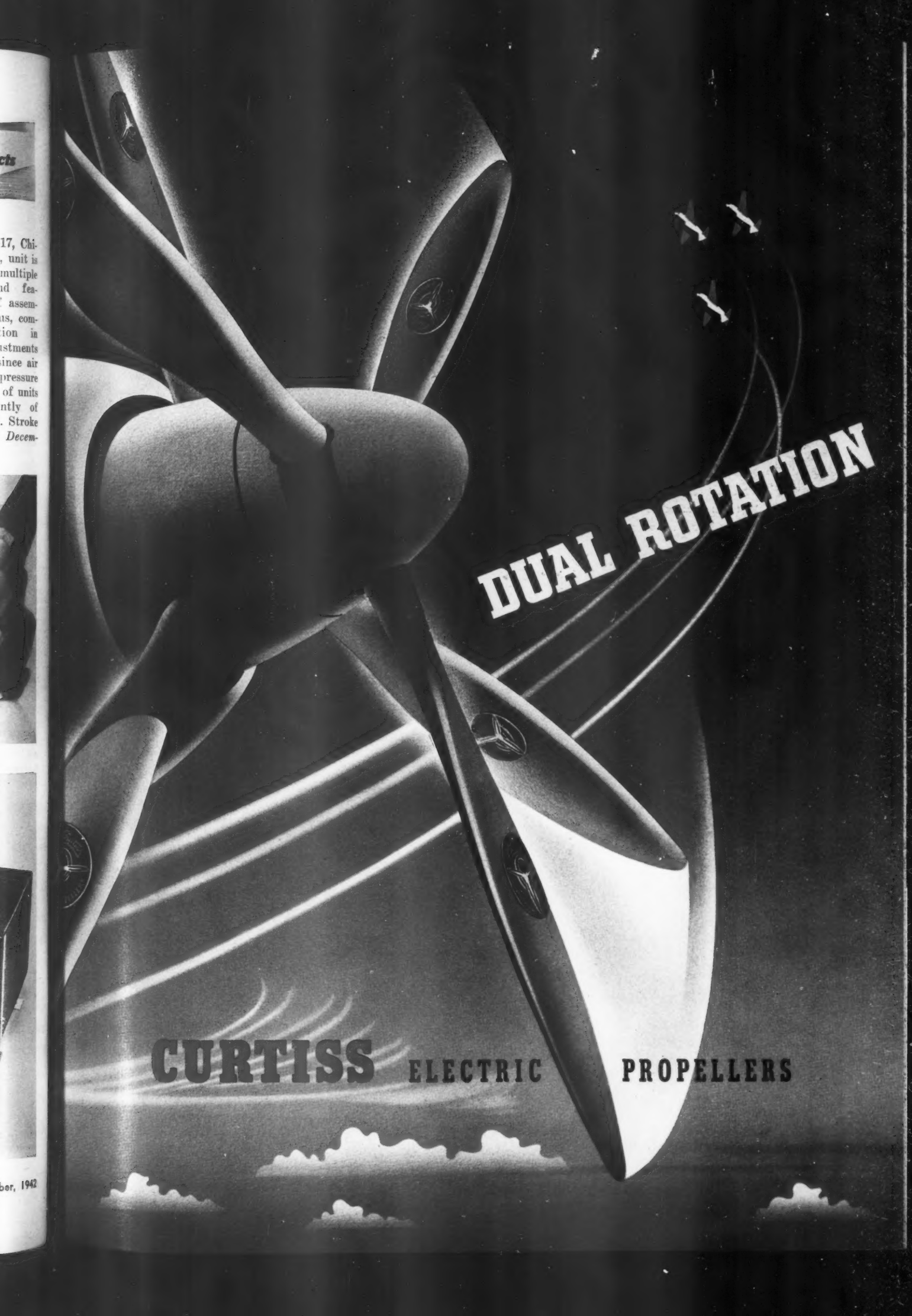
## Power Lift Truck. . . . . 41

A new electrically operated lift truck called the PowerOx marks entry into the power driven lift field by **Barrett-Craven Co.**, 3262 W. 30th St., Chicago, Ill. Capacity of the new unit is 4,000 lb., widths are 19 and 25 in., platform lengths are 48 and 60 in., and lowered heights are 7, 9 and 11 in. Two electric motors drive rear wheels independently. Lift mechanism is the standard Barrett unit of multiple stroke design. Batteries provide for 8 to 12 hrs. continuous operation. Motive power is applied by hand control—forward or backward twist of the wrist determining direction. —AVIATION, *December,* 1942.

## Small Air Clamp . . . . . 42

Convenient-sized air clamp delivering 80-lb. pressure on line pressure of 100 lb., has been designed for aircraft industry by **Mead Specialties Co.**, 15 S. Market St., Department M-17, Chicago. Known as Mead Midget, unit is for assembly jigs and other multiple applications. Description and features: Lock-up and release of assemblies is said to be instantaneous, compact size permits installation in cramped corners, special adjustments are stated to be unnecessary since air clamps ram holes with equal pressure at any point along bulk. Group of units can be controlled independently of other groups in given assembly. Stroke of the ram is $\frac{5}{8}$ in.—AVIATION, *December,* 1942.




DUAL ROTATION
CURTISS ELECTRIC PROPELLERS

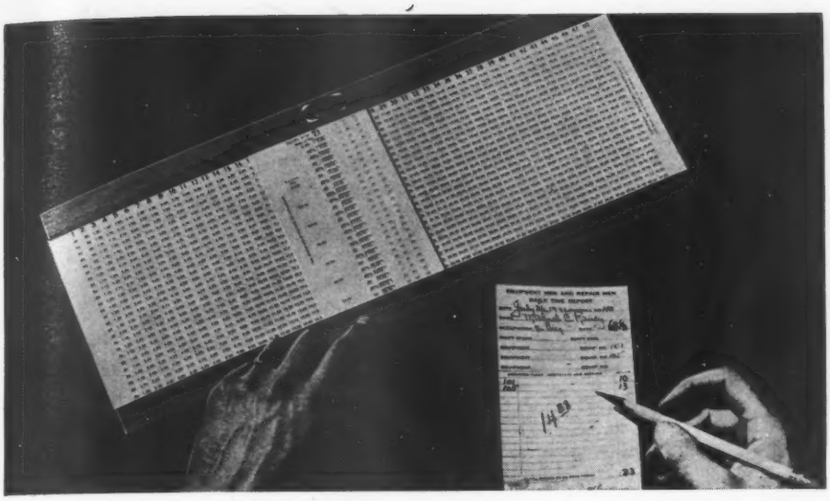
# NAVY'S NEWEST DIVE BOMBERS CLIMAX *23 Years* OF PIONEERING

Twenty-three years ago U. S. Marine aviators pioneered precision bombing with fighter planes aimed at the target in a dive. By 1926 the U. S. Navy was developing aircraft especially designed to withstand the unprecedented stresses imposed by this new technique. Fleet squadrons were performing regular training operations in dive bombing tactics.

Today this unrivalled background of engineering, technical development and experience has made possible the modern dive bombers now in production by Brewster and other manufacturers.

BREWSTER *Blasters*

BUCCANEER AND BERMUDA DIVE BOMBERS



## New Products

### Wage and Cost Calculator . . . 43

Payroll and job costs are stated to be calculable in fraction of usual time through use of device offered by **Berger-Bricker Co.**, 433 S. Spring St., Los Angeles. Calculator includes all hourly rates of pay from 50c. to $1.75, with ½c. spread between rates. It covers all time periods up to 104 hours with 1/10-hr. divisions.—AVIATION, *December*, 1942.

### Engine Assembly Stand . . . . . 44

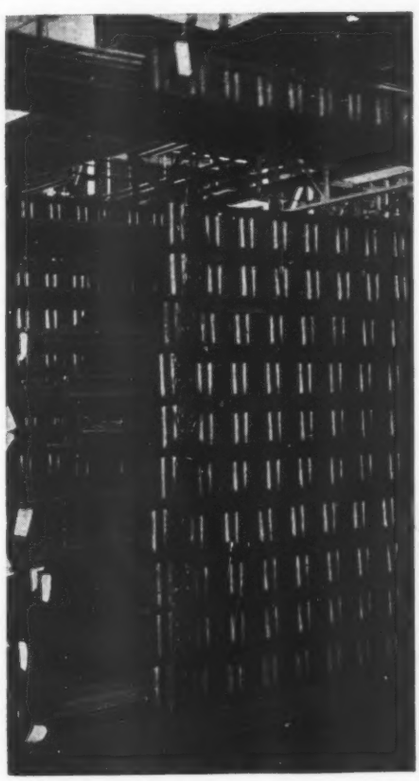
A new engine assembly stand, known as the Model E3, for holding large in-line aircraft engines in any desired position during assembly or overhaul, is now being manufactured by the Aviation Division, **Whiting Corp.**, Harvey, Ill. Its important features are the rotating rings and horizontal tubular members to which the engine brackets are bolted. This design reduces the stand's superstructure to a minimum and provides complete accessibility to all parts of the engine at all times during its build-up. The engine is quickly and easily bolted into position and the entire unit is readily maneuverable in the production line or other congested places.—AVIATION, *December*, 1942.

### Metal Cutting Coolants . . . . . 45

A new line of metal cutting coolants has been developed by the **Gray-Mills Co.**, Chicago, Ill., enabling their nation-wide distribution outlets to offer immediate deliveries from stock. Realizing the inconvenience to many shops in purchasing large quantities, the new Gray-Mills "Flo-Bac" coolants are offered in a wide range of container sizes: 3, 5, 15, 30, 50 and 55 gal. They are manufactured in four types to cover practically every requirement and are available in wooden containers (to conserve steel and expedite shipments) on priorities up to A-10. Steel containers require A-1-J or better.—AVIATION, *December*, 1942.

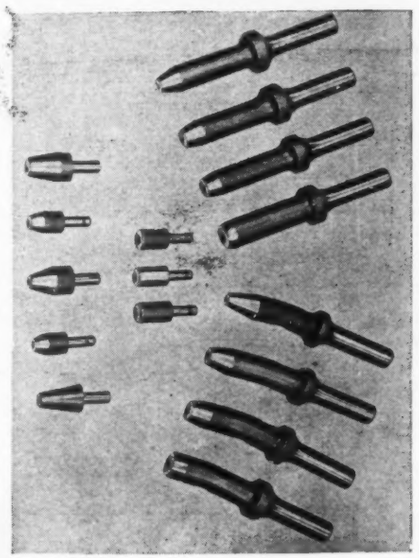
### Bar and Part Storer . . . . . 46

For movement and storage of long bars and odd-shaped parts, the **Union Metal Mfg. Co.**, Canton, Ohio, has developed a special open-end inverted skid. Applicable for aircraft plant use, unit was formed from company's standard all-steel skid platform, turned upside down and equipped with eyed brackets for insertion of crane hooks. —AVIATION, *December*, 1942.



### Rivet Sets . . . . . 47

Enlargement of its line of **Aerocraft** rivet sets to include practically **every** type known to be in use in aviation industry is announced by **Aircraft Tools, Inc.**, Los Angeles. Line now **includes** all standard sizes of straight-type round head, brazier head, flat head, and modified brazier head, from 3/32 to ¼-in. dia.; offset-type with round head,



brazier head, flat and modified brazier head from 3/32 to ¼ in.; swivel type flush rivet sets, straight flush rivet sets with 1½-in. heads, and hand rivet squeezer sets in 3/32, ⅛, 5/32 and 3/16-in. round and brazier heads.—AVIATION, *December*, 1942.

### Junior Pneumatic Vise . . . . . 48

New addition to line offered by **Production Devices, Inc.**, Poultney, Vt., is Airlox Junior pneumatic vise for milling, drilling, tapping, filling, and assembly operations. Quick acting for speedy operation, unit is stated to offer these features: Accessible screw adjustment to locate adjustable jaw, bolts to lock jaw in position, inclosed mechanism to afford protection from chips or foreign elements, and key-wayed design for precision work. Specifications: Dimensions 10x5 7/16x4½ in.; jaw width, 4¾ in., depth 1⅛ in.; weight approximately 25 lb., and gripping force on work approximately 20 times air line pressure during last 1/16 in. of jaw travel.—AVIATION, *December*, 1942.

Speed
Accuracy
Low In Cost

# HONE TO VICTORY

Super-Smooth Finish
Inexpensive to Operate

## With THE SUNNEN PRECISION HONING MACHINE

***SPEED*** **to meet today's ever-increasing demand for vital implements of mechanized war.**

***ACCURACY*** **to insure fewer rejects and absolute interchangeability of parts. Super-smooth finish.**

***LOW COST*** **— Both initial and operating.**

***WIDE RANGE*** **— Handles any internal diameter from .185" to 2.400".**

***EASY TO OPERATE*** **— Workers in "teens" — even girls — can be trained to do expert work in a few hours.**

***CONSERVES*** **— Relieves big internal grinders for other jobs. No fixtures needed — work held in hand.**

**These are only a few of the reasons why it will pay you to put Sunnen honing to work in *your* plant — as it has hundreds of leading manufacturers.**

**Aluminum Aircraft Link "produces high finish without bell-mouthing."**

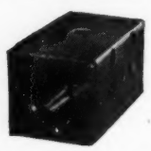
**Inner Bearing Ring "Accurately removes last 'tenth' of stock."**

**"Strict alignment maintained between two holes."**

**Drawing and Blanking Die "Saves time in producing smooth base metal finish."**

**Bronze Valve. The Sunnen method of honing is used to secure a high finish and accuracy.**

**Cones for Wheel Balancing Machine "Accurately align hones two interrupted surfaces."**



**Saved time in producing a smooth, accurate finish on this bronze remote control valve body.**

**Aviation Hydraulic Cylinder made of Aluminum-Alloy. Improves the quality of the bearing surface. An extremely smooth surface-finish is secured.**

**Diesel Engine Fuel Injector Cylinder "So accurate that a piston can be fit within .00005 inch."**

**Aircraft Valve Tappet Roller. 4-Micro finish.**

**Hardened Steel Inner Bearing Race honed to .00005" limit. Surface finish improved; errors of out-of-roundness eliminated.**

**Drill Jig Bushing "Increases sales appeal of product."**

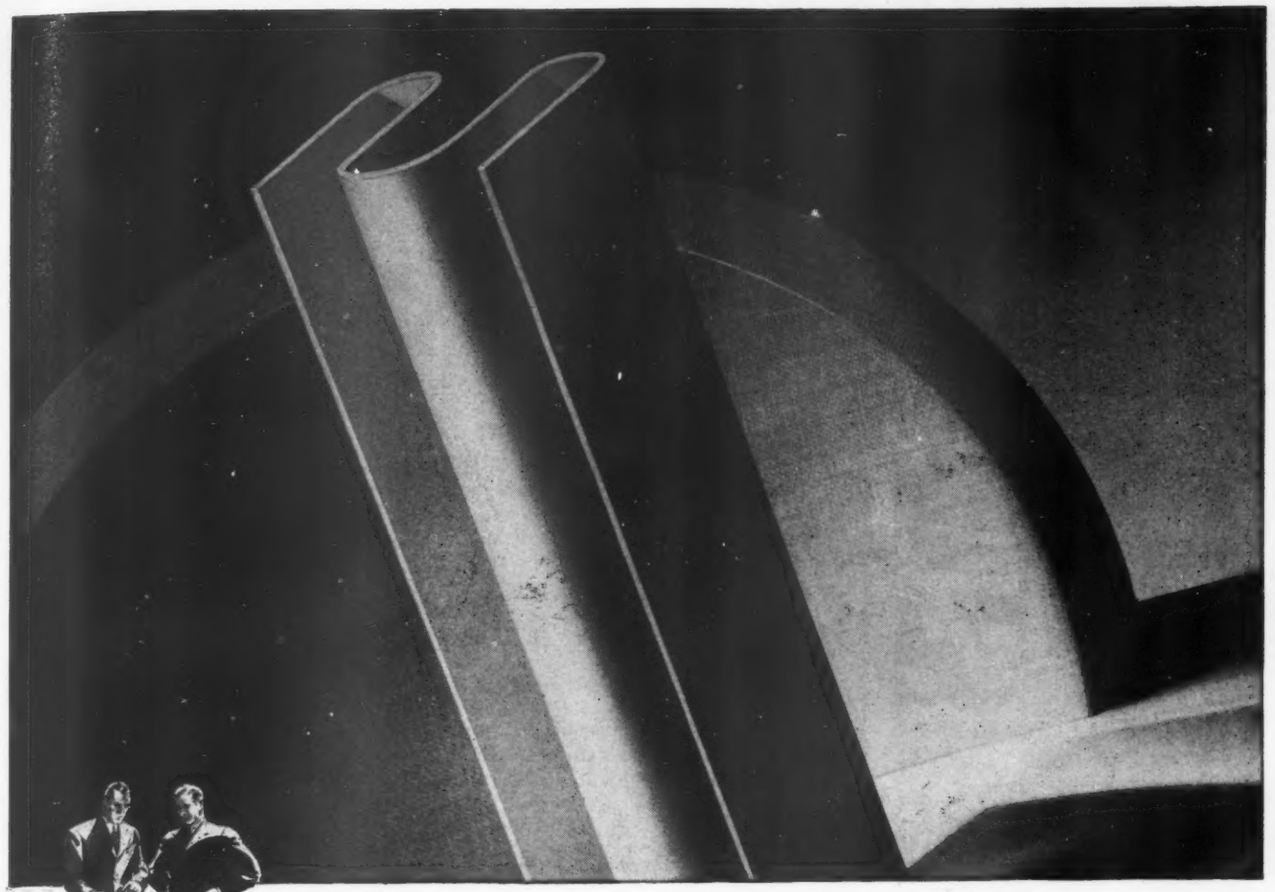
SUNNEN

***Write for FREE BULLETIN***

giving complete information or, if you prefer, a Sales Engineer will be glad to call with his demonstrator and show you what this machine can do on your job.

**SUNNEN PRODUCTS CO., 7942 Manchester Ave., St. Louis, Mo.**

*Canadian Factory: Chatham, Ontario*



# Here's something else that "Couldn't be done"

WITHOUT fuss or fury, many limitations have been overcome in the manufacture and use of plastics. Molded INSUROK parts, for example, are being produced in large quantities for war uses so important that they cannot be mentioned. And now Laminated INSUROK is being formed into "accordion pleats" and other shapes to solve another category of production problems.

In addition to extending the ways in which INSUROK can serve the armed forces, *Richardson Plasticians* are helping designers take full advantage of this versatile material, are helping many manufacturers increase their output per machine-hour.

If you have a problem which molded or laminated plastics might solve, write us. We'll be glad to furnish the details and characteristics of INSUROK Precision Plastics — or give you the benefit of our experience.

The Richardson Company, Melrose Park, Illinois; Lockland, Ohio; New Brunswick, New Jersey; Indianapolis, Indiana. Sales Offices: 75 West Street, New York City; G. M. Building, Detroit, Michigan.

**INSUROK** *and the experience of Richardson Plasticians are helping war products producers by:*

1. Increasing output per machine-hour.
2. Shortening time from blueprint to production.
3. Facilitating sub-contracting.
4. Saving other critical materials for other important jobs.
5. Providing greater latitude for designers.
6. Doing things that "can't be done."
7. Aiding in improved machine and product performance.

# INSUROK

MADE AND SOLD ONLY BY THE RICHARDSON COMPANY

# gain hours

**Use Laminum shims to reduce parts machining for easier work tolerances in factory adjustment! More machine hours released for production.**

**Laminum shims (.003 or .002 inch precision laminations bonded into a solid unit) are cut to your specifications.**

***Stock shim materials obtainable from mill supply distributors. (Write us for sample and illustrated shim application chart.)***

**Laminated Shim Company**
**Incorporated**
**80 Union Street** **Glenbrook, Conn.**

*it's*

**LAMINUM**

THE SOLID SHIM THAT *peels* FOR ADJUSTMENT


## Cushion-Bonded Clamps. . . . . 49

Cushioned and integrally bonded clamps meeting AAF specifications are being produced by **Automotive Rubber Co.**, Department A, 8601 Epworth Blvd., Detroit. Bonding is provided by using bonding strip attached to clamp securely by spot welding. Neoprene-

cushioned clamps use specially compounded Neoprene permitting minimum material with maximum cushioning through wide temperature range. Clamps may also be supplied with felt, leather, or plastic cushions.—AVIATION, *December,* 1942.

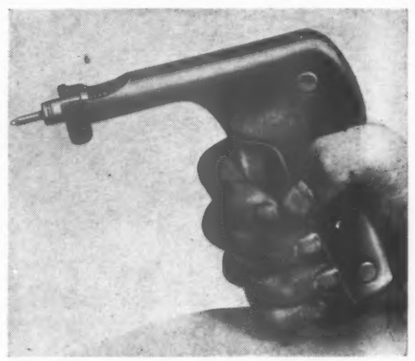
## Exploding-Rivet Gun . . . . . 50

Manufacture of new electric heating gun for exploding rivets in hard-to-reach parts of planes is announced by **Westinghouse Electric Appliance Division**, East Pittsburgh. Heat shot by tool into special duPont rivet sets off charge within 2 to 6 sec. Principal

parts of unit are modifications of key parts of electric ranges and household irons made in peacetime. Operator selects temperature needed depending on size of rivets, and gun's firing time can be controlled to gain full force of explosion.—AVIATION, *December,* 1942.

## Skin-Assembly Gun . . . . . 51

For assembling skin holders to aircraft sheets, **Prestole Division, Detroit Harvester Co.**, Toledo, has produced Prestite Safety Champ gun. Light weight and balance of unit minimize fatigue, says company, making it es-



pecially suitable for women workers, and automatic gun-type grip provides greater leverage. Feature is use of steel-hardened, replaceable clips in muzzle. Gun accommodates all popular sizes of skin holders.—AVIATION, *December,* 1942.

## Aircraft Varnish . . . . . 52

V-116 aircraft varnish has been developed by the **Wilbur & Williams Co.**, Park Square Bldg., Boston, to meet Army-Navy specifications AN-TT-V-116 for varnish for use primarily on wooden surfaces, such as plywood used in plane production. Specification for varnish preventing raising of grain of plywood and which will not check or peel is stated to be met to letter by V-116.—AVIATION, *December,* 1942.

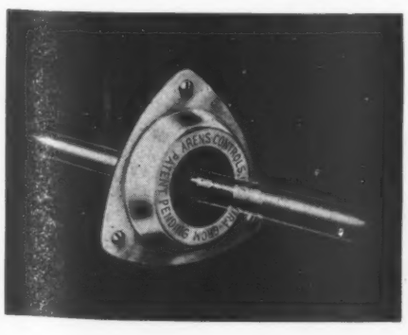
## Hydraulic Valve . . . . . 53

Designed to permit installation of multiple hydraulic controls in limited space, such as cockpit control panels, without material weight increase, is new Stacking Midget valve announced by **Adel Precision Products Corp.**, Bur-

bank, Calif. Companion to previously announced Mighty Midget four-way selector valve, new stacking valve measures 5$\frac{31}{32}$x2$\frac{7}{16}$x3$\frac{3}{16}$ in. and weighs 2.9 lb. Individual valve assemblies may be replaced or repaired by breaking only two cylinder lines affected. Fitting as single body, any number of units may be clamped together by means of "through" bolts and end plates which also serve as flanges, and symmetrical design permits turning end-for-end to meet desired shaft arrangements. Over-travel is prevented by integral stop located on cam shaft. Complete interchangeability of valves and assemblies assures maintenance ease and reduces parts stock requirements.—AVIATION, *December,* 1942.

### Line and Cable Grommet . . . 54

Fume and watertight support for air, oil, and hydraulic lines, electrical cables, flexible remote control casings, etc., is enabled with Dura-Grom grommet, according to **Arens Controls, Inc.,** 2253 S. Halstead St., Chicago, maker. Unit, consisting of oil-resisting synthetic rubber disks and cadmium plated steel cup retainer, slips over line, cable, or tube and fits snugly against wall. Multiple lines may be supported by single grommet, with individual opening provided in disks for each line.—AVIATION, *December,* 1942.





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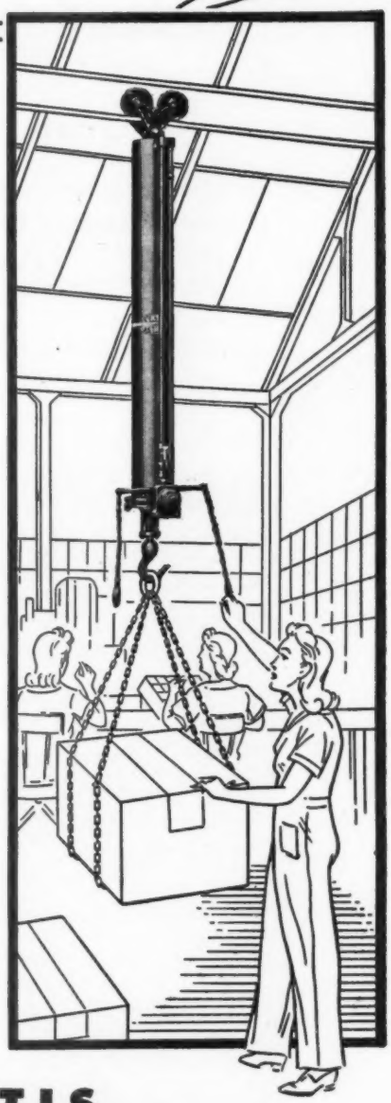

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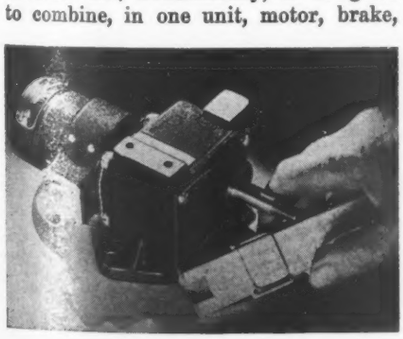
## Riveter Time-Cycle Unit

New Murray Time-Air, of which manufacturing and selling rights have been acquired by **Chicago Pneumatic Tool Co.**, 8 E. 44th St., New York, is device for mechanical determination of proper riveting time cycle. Developed by Murray Research Division, it is light, compact, precision unit which

when attached to handle of portable riveting gun can be controlled by operator either automatically or manually. After full depression of trigger in automatic operation, timer delivers predetermined time cycle, then stops. By pulling trigger slightly back, hammer operates as long as trigger is so held, permitting trim-up or occasional longer cycle. Time cycles are set by small adjustment dial, and pressure control may be regulated for thin or soft material. Device may also be used on pedestal riveters with foot-pedal control.—AVIATION, *December*, 1942.

## New Power Package . . . . . 56

Power package offered by **General Electric Co.**, Schenectady, is designed to combine, in one unit, motor, brake, clutch and limit switch, as well as indicators, gears, and whatever else is required. Designed for 24-hour service and obtainable in ratings from about 1/100 hp. to 3 hp., units are applicable for bomb-door operation, landing gear and wing flap operation, and actuating of control and protective devices. New planetary gear system permits use of magnetic brake for some applications. Brake is of quick-acting friction type, stopping motor instantly to prevent overtravel and consequent jamming of driven plane assembly.—AVIATION, *December*, 1942.



## Fluorescent Lights . . . . . 57

**R & W Wiley, Inc.**, 777 Hertel Ave., Buffalo, has developed fluorescent lighting fixtures employing a new method of ballasting said to give positive and in-

## *Those curves look awfully good!*

**"Good," is right! 1500% increase in production since the War began is the latest report—bringing within easy sight the plane quotas set for 1942 and 1943.**

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stataneous starting so that lights come on fully at the turn of the switch as in incandescent lighting. Other features are said to include positive starting at lower atmospheric temperatures and lower voltage, no radio interference and satisfactory tube life. Available in types for all applications, continuous or separate units, close-to-ceiling or suspended mounting, open reflector or louvred models.—AVIATION, *December*, 1942.

## Tensile Strength Testers . . . . 58

Model B tensile testers, developed by **W. B. Dillon & Co.**, 5410 W. Harrison St., Chicago, are offered in portable table and floor units. Though

small in size, table model will physically check specimens up to foot in length, accommodate up to 9 in. width, and handle up to 10,000 lb. With provision of grips, special tests such as separational pull of sockets (photo shows test of aircraft socket) can be made. Dynamometer stress indicator permits wide limits of measurement with uniformly small stress-reader. Height starts at 32 in. (table model) to 78 in. (floor type).—AVIATION, *December*, 1942.

## Portable F-I Pump . . . . . 59

Latest in line of "Pile Drivers" made by **Lincoln Engineering Co.**, 5701 Natural Bridge Ave., St. Louis, is "50" Series portable forced-induction pump. Unit, states company, will pump sealing compounds, sound deadeners, insulating material, heavy lubricant, etc., directly from original container to point of application. Portability of pump is feature.—AVIATION, *December*, 1942.

## Torque Wrenches. . . . . 60

Creation of complete line of torque wrenches affording wide range of application is announced by **P. A. Sturtevant Co.**, Addison, Ill. Tools are designed for assembly and inspection gaging of torque applied when tightening critical screws and bolts and to equalize, control, or bring screws to predetermined torque. Eight models range in size and capacity from small instrument-building wrenches of very low inch-pound capacity to two-handled torque wrenches of 7,200-inch-pound capacity. All are of flat, tapered-beam type with fixed end and top scales.—AVIATION, *December*, 1942.

## Hydraulic Test Bench. . . . . 61

Portable hydraulic test bench for pre-flight checking of hydraulic circuit of planes has been brought out by **Hydraulic Machinery, Inc.**, 10421 Grand River, Detroit. Testing includes putting planes through all hydraulic functions without running engine. Equipment consists of hydraulically operated air compressors (high or low pressure) for purpose of charging hydraulic accumulators. Can also be used

to pump hydraulic fluids in and out of planes, and variable-displacement pump permits unit to operate hydraulic circuit at different speeds. There is adjustable pressure range of 0 to 1,000 lb. per sq. in.—AVIATION, *December*, 1942.

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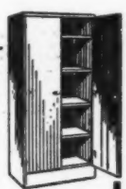

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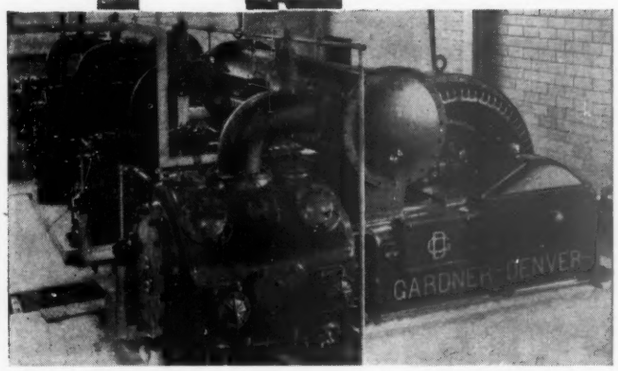


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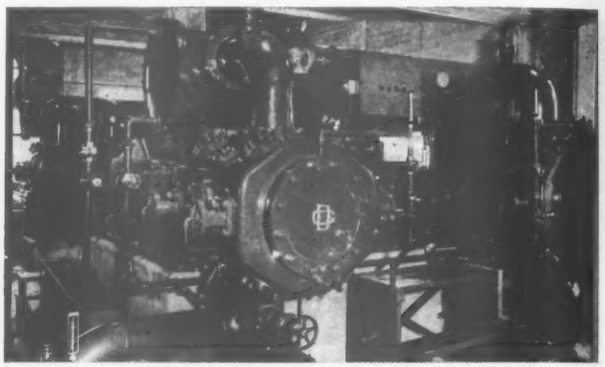
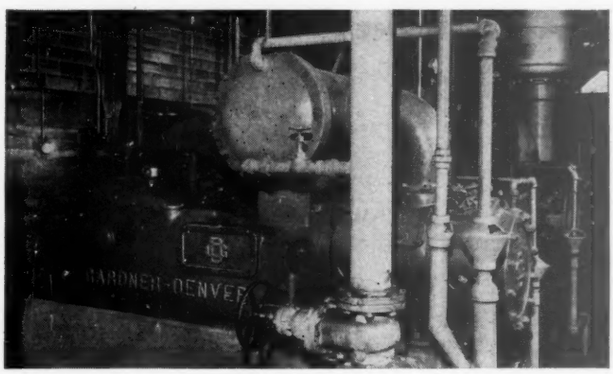


**AUTOMATIC CONTROL**—There is no wasted power in operating an "HA" compressor, for the air capacity is under constant, automatic control—and the air supply is constantly regulated to fit your air needs.

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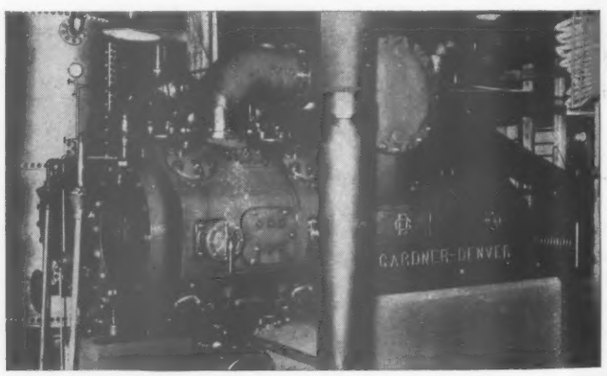


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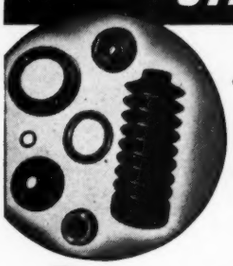

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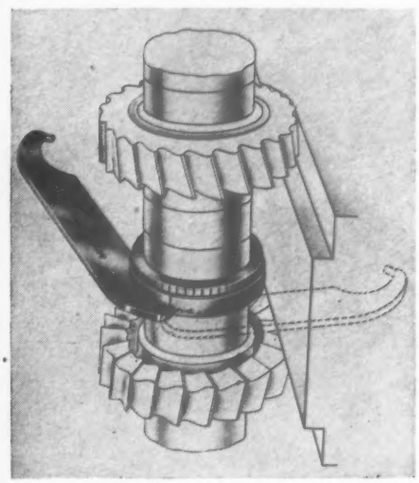
## New Products

### Spacing Collar Wrench ..... 62

Illustrated spacing collar adjusting wrench, a double end pin spanner tool, is now furnished with eleven different sizes of micrometer adjustable spacing collars for milling machine cutter ar-



bors offered by **Dayton Rogers Mfg. Co.**, 2835 Twelfth Ave. S., Minneapolis. Wrench permits micrometer adjustment of collar governed by micrometer sleeve.—AVIATION, *December*, 1942.

### Light Weight Drill ..... 63

New Size OOA pneumatic drill, weighing less than 2 lb., has been introduced by **Ingersoll-Rand Co.**, 11 Broadway, New York. Powered by efficient air motor, light weight drill is sturdily built for three-shift endurance in making of aircraft. Reported features: Built-in speed regulator for desired performance setting, split second travel action for quick and accurate hole starting, lubrication by built-in automatic oiler, and protective chuck shield, which may be grasped by free hand for more effective guiding of drill.—AVIATION, *December*, 1942.

### Airfoil Demonstrator ..... 64

Kahlow Flight Demonstrator is 10-lb. boxed device for use in pre-flight and ground school instruction. Comprises miniature wind tunnel with actuated wing section which illustrates lift, drag, changes of pressure, stall, and characteristics of ailerons and flaps in flight. Agent for device is **Gordon Laughead**, Story & Clark Piano Co., Grand Haven, Mich.—AVIATION, *December*, 1942.

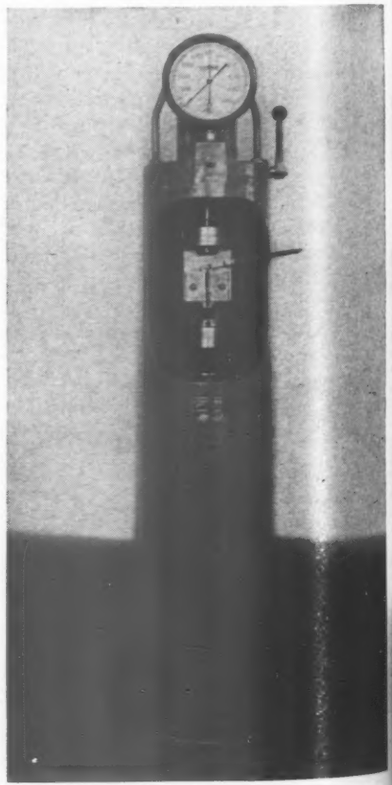
### Wood-Fiber Material ..... 65

Fybr-Tech, product of **Technical Ply-Woods**, 228 N. LaSalle St., Chicago, is offered for use by plane makers for construction of bulkheads, partitions, floors, table covers, conduit covers, etc. Consisting of veneer or plywood core with sheets of vulcanized fiber resin bonded to each face, material is reported to have unusual strength and lightness. Of tough, hornlike surface, non-slipping and resistant to cuts and scratches, it can, states the maker, be sawed, drilled, die-punched, and readily bent, taking sharp radii with ease. It is stated to take all types of finishes, air dried and low-baked synthetic enamels reflecting an even, smooth finish.—AVIATION, *December*, 1942.

### Spot Weld Tester ..... 66

To check strength of spot welded sample, testing machine shown has been developed by the **Baldwin Southwark Division** of the **Baldwin Locomotive Works**, Philadelphia. Self contained and motor driven, hydraulic machine is equipped with self-aligning, lever-operated, open-faced grip which accommodates offset in welded specimen from the smallest gage to ¼-in.

(*Turn to page* 215)



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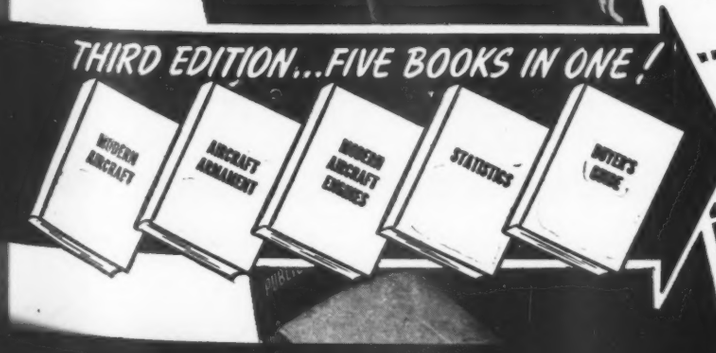


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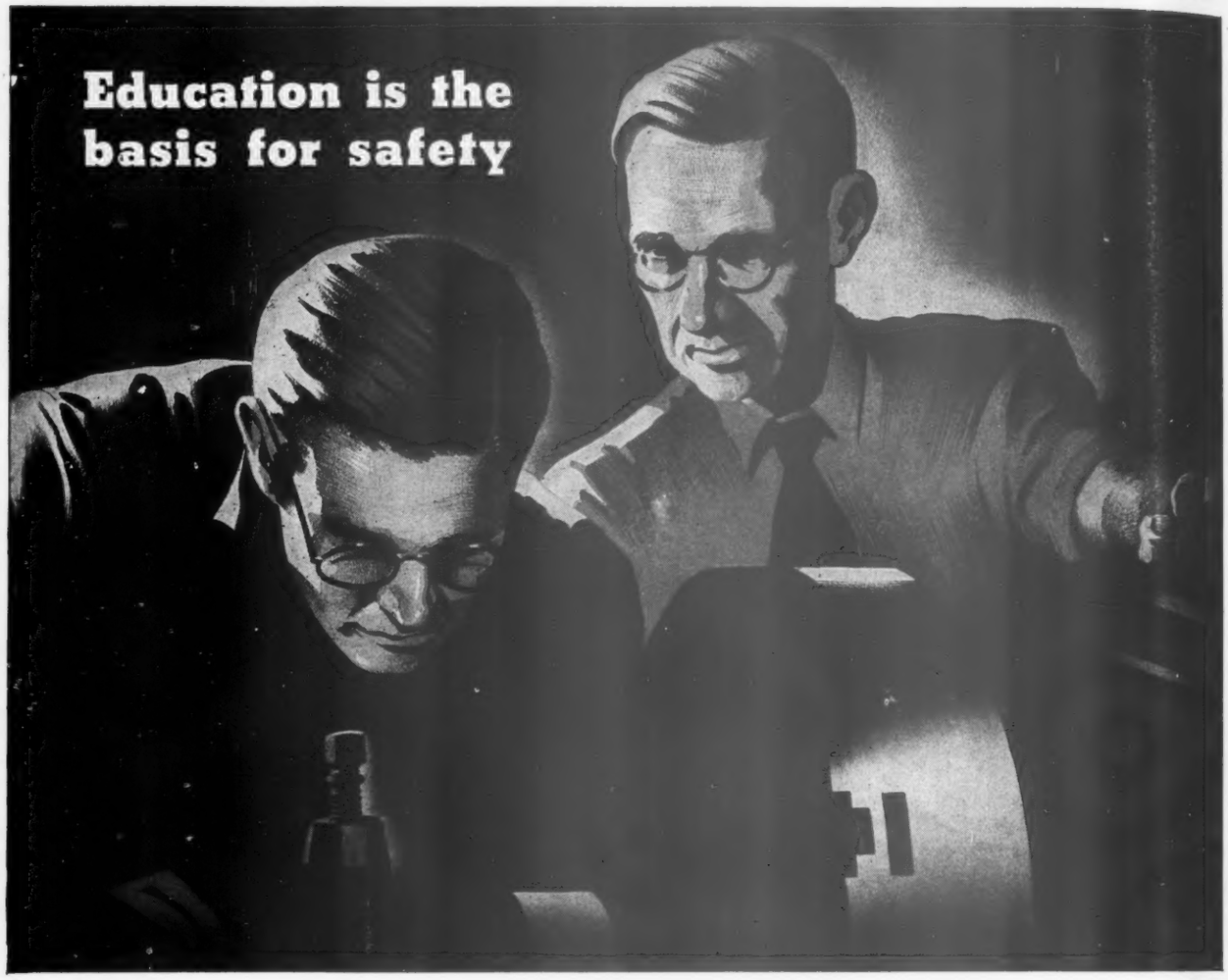


*Information supplied by the National Safety Council*

Labor, particularly inexperienced labor, cannot be expected to recognize the full penalties of carelessness in the shop. Management has assumed the responsibility of supervising safety measures, and has cooperated in establishing sound safety rules.

Nevertheless, the large increase in labor personnel due to war needs, plus the influx of inexperienced men, have resulted in a substantial increase in lost time accidents.

Even assuming that the obvious safety measures with regard to operating machinery, electrical equipment and shop traffic have been installed, two factors — education and eternal vigilance — determine the real effectiveness of any safety program.

Both are the responsibility of the supervisory staff, from foremen up. The foreman who does a thorough job of educating his particular group in safety rules and cooperative enforcement has done much to cut down accidents. Management that takes an active interest in both safety education and the enforcement of safety measures has taken a great step forward in reducing wastage of irreplaceable production time.

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## New Products

thickness. No backing plates or liners are needed. Load is indicated by 8-in. precision dial. Cylinders, with 2-in. stroke, are set in top section. Unit has over-all height of 70 in. and total weight of approximately 800 lb.—AVIATION, *December,* 1942.

### Pilot's Seat . . . . . 67

New pilot's seat for military aircraft combining several non-strategic materials is announced by **Harvill Corporation,** Los Angeles. Only metal parts are mounting brackets, shoulder harness, and adjusting fittings. Plastic-impregnated fabric is used with special wood structures to produce seat

which is light, yet meeting all strength specifications. One basic type meets AN-7505 specifications for pursuit and training planes, another AN-S-1 requirements for long-range bombers. As no heat or pressure is used in fabrication, field repairs are simplified.—AVIATION, *December,* 1942.

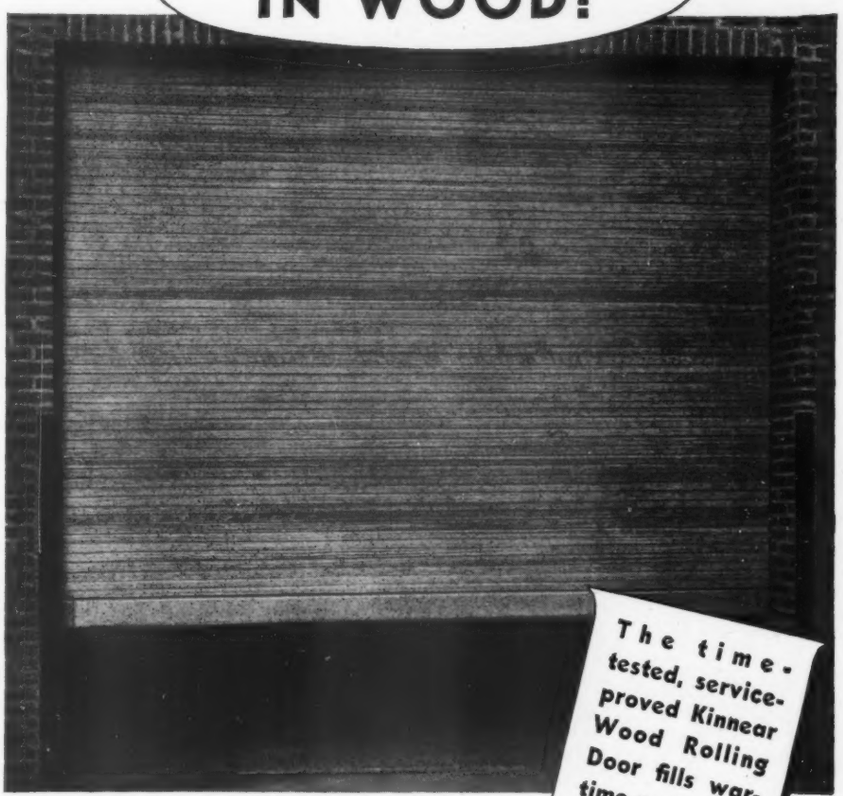
### Powder-Metal Parts . . . . . 68

Latest development of **Bound Brook Oil-Less Bearing Co.,** Bound Brook, N. J., is Powdiron, powder metallurgy product made into parts and bearings to meet war demand for savings on material and to eliminate need for machining. There are three distinct formulae of Powdiron, with specifications providing porous iron alloys containing no tin and copper from 0 to 10 percent maximum, and it is adaptable to a wide variety of conditions and applications. Can be had either with or


You Want the Efficiency of Kinnear Steel Rolling Doors

YOU CAN GET IT--

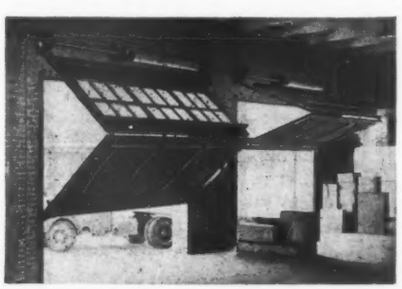
IN WOOD!



The time-tested, service-proved Kinnear Wood Rolling Door fills wartime needs, but saves critical materials.

You can get the efficient, space-saving *coiling upward action* of Kinnear Steel Rolling Doors in spite of wartime contingencies—in Kinnear Wood Rolling Doors. Their durability and service has been thoroughly proved on numerous installations for many years!

Constructed of inter-lapped wood slats jointed with metal cables or tapes, they coil above the opening, remain out of the way and out of reach of damage, require no usable floor, wall or ceiling space for either storage or operation. The rugged curtain assembly offers a high degree of protection, and blocks out wind and weather. Kinnear Wood Rolling Doors are available in any size, with motor, manual or mechanical operation. Write for bulletin 37, containing complete details.



ANOTHER KINNEAR WOOD DOOR FOR TODAY'S NEEDS

KINNEAR BIFOLD consists of two horizontally hinged sections. Pivoted at top corners; lower corners travel on ball-bearing rollers in metal jamb guides. Folds to overhead position. Available with any number of sash, and spring-counterbalanced for smooth, easy action. Any practical size; quick, economical installation. Write for details.

THE KINNEAR MFG. CO.

1440-60 Fields Ave. Columbus, Ohio

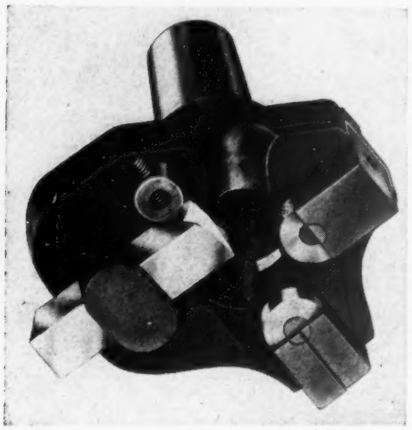
SAVING WAYS IN DOORWAYS

KINNEAR ROLLING DOORS

without lubricant impregnation, with up to 25 percent oil content.—AVIATION, *December*, 1942.

## Screw Machine Tool . . . . . 69

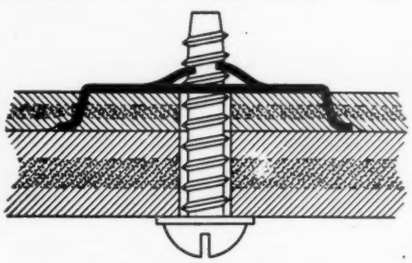
Known as Model B, screw machine tool now marketed by **Boyar-Schultz Corp.**, 2110 Walnut St., Chicago, is designed to take heavy cuts with sus-



tained accuracy. It has swiveling tool bit and separately adjusted rollers for easy adjustment. There is generous space for chips and coolant.—AVIATION, *December*, 1942.

## Plywood Lock-Nut . . . . . 70

Self-locking speed nut for plywood assemblies is offered by **Tinnerman Products, Inc.**, 20-70 Fulton Rd., Cleveland. With two pair of integrally formed attaching legs, it is designed for instant driving into anchored position. Lightness is feature, nuts weighing only 3½ lb. per 1,000, and large bearing surface is stated to spread load over greater area. Nuts



are made for use on both Air Corps 530-8 and Air Corps 530-10 standard type "Z" sheet metal screws.—AVIATION, *December*, 1942.

## Quick Action Vise . . . . . 71

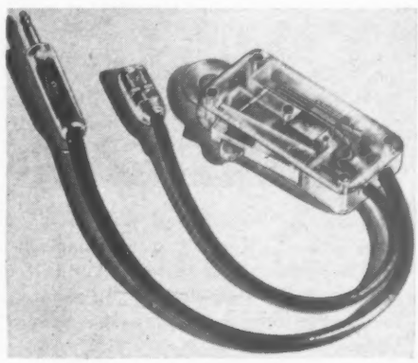
**Pacific Vise Co.**, 6331 Hollywood Blvd., Los Angeles, Calif., has developed a quick action vise using a patented nut and pawl which makes it possible to open and shut the vise like a drawer and lock it in any desired position with but two turns of the handle. All working parts are of steel, precision machined, fully enclosed and all parts are interchangeable. A new-type swivel base locking bar with two screws assures positive lock in any position and equalizes strain. Available in 4½, 6 and 7-in. sizes with both swivel and solid base types.—AVIATION, *December*, 1942.

## Non-Magnetic Bearings . . . . . 72

NM4 and NM5-radial and NM3P-pivot bearings are non-magnetic series bearings now offered by **Miniature Precision Bearings**, Keene, N. H. Series has races and balls manufactured of Berylco No. 25, beryllium copper alloy hardened after machining by heat treatment to approximately 40 Rockwell. Dimensions and tolerances are identical with SAE 52100 chrome-steel bearings marketed by firm.—AVIATION, *December*, 1942.

## Air-Ground Phone Unit . . . . . 73

Introduced by **American Radio Hardware Co.**, 476 Broadway, New York, SM-141 phone switch is offered as a connecting-link unit between air



and ground communications. It is a double circuit microphone switch designed for easy use by operator wearing heavy mittens. Remaining normally in open position, it can be locked into closed position. Switch is 4⅜ in. overall, ¾ in. thick, and 1¾ in. wide. Integral parts of housing include cordage clamps to take up cable strain.—AVIATION, *December*, 1942.

## Electrical Cable . . . . . 74

Announcement comes of new series of Auto-Lite Sterling low tension aircraft electrical cable known as "B" Braid Synthetic. Approved under Army-Navy Specification AN-JC-48 in sizes from 22 GA. to OO GA., cable is made by Wire Division of the **Electric Auto-Lite Co.**, Port Huron, Mich. Flame-resistant insulating compound used on cables is synthetic, protected

by special cotton braid, with newly developed lacquer with high abrasion resistance. Cable is small in size and low in weight.—AVIATION, *December*, 1942.

## Angle Drilling Heads . . . . . 75

Specially applicable to aircraft assembly, and for work in close quarters generally, are new Wyco angle drilling heads for use on flexible shaft or flexible shaft extensions of portable electric drills. Designated as "Junior" size, they come with 90 deg., 45 deg., 30 deg., or universal heads and have over-all diameters of ½ or ¾ in. Maker is **Wyzenbeek & Staff, Inc.**, 836 W. Hubbard St., Chicago.—AVIATION, *December*, 1942.

## Thiokol-Made Gaskets . . . . . 76

Development of non-critical materials for certain gasket and stripping requirements is announced by **Felt Products Mfg. Co.**, 1530 Carroll Ave., Chicago. Fel-Pro Thiokol strip material, with spongy effect of rubber is weather resistant.—AVIATION, *December*, 1942.

## New Gas Tank Cap . . . . . 77

Aircraft gasoline tank cap assembly introduced by **Poulson & Nardon, Inc.**, Los Angeles, has brought savings in critical materials, and through stamping process many of former welding operations have been eliminated. In manufacture, sheet stock is drawn into tubular sections, and lugs for holding cap to tank portion of assembly are automatically formed during stamping operation.—AVIATION, *December*, 1942.

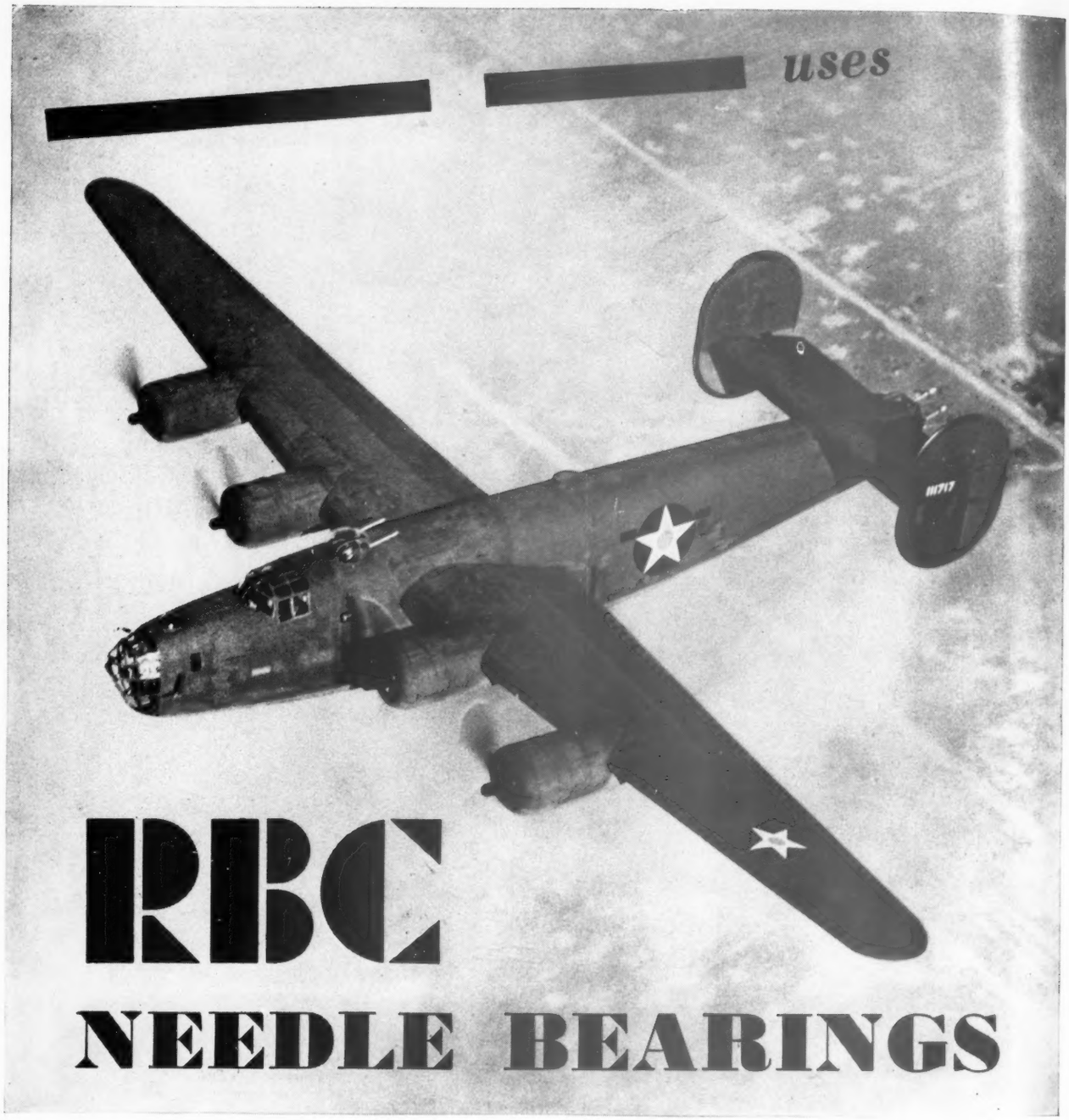
# UNSEEN BUT *HEARD* FROM

The planes that dropped devastation on these Jap warships were unseen, but their *telling effect* was very much there!

Pesco Pumps and related aircraft accessories are not in open view on the plane but their foremost performance is very much there!

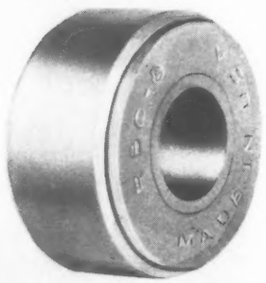
Pesco

Division of Borg-Warner
Cleveland, Ohio

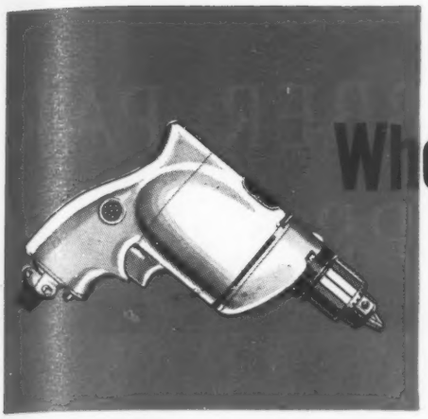



# RBC
# NEEDLE BEARINGS

Mission accomplished . . . headed for home and a happy landing! When they're flirting with death above the clouds, the pilot and crew have at least the right to expect that their ship can be set down smoothly and safely. That's why the landing gear of _____ _____ Bombers are equipped with RBC Aircraft Bearings.



**ROLLER BEARING CO. of AMERICA**
**TRENTON . . . . NEW JERSEY**



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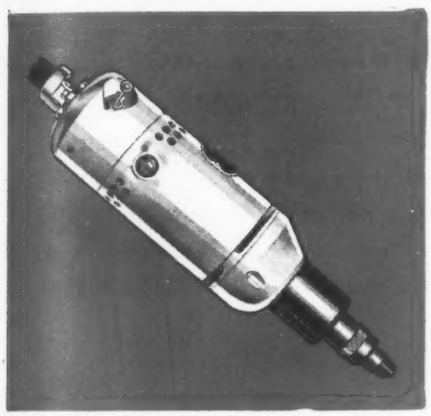
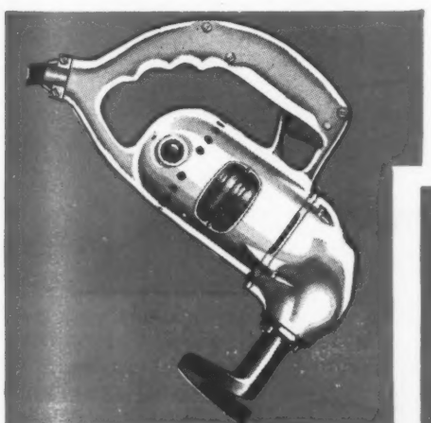
**ELECTRIC DRILLS**—capacities from ¼" to 1¼"—including the famous HOLGUN—with wide choice of spindle speeds and handle arrangements for every type of aircraft work.



**POWER DRIVERS**—sizes to drive anything from small screws to large nuts and bolts; clutch adjustments, angle heads and controls to drive all threaded-fastener assemblies.

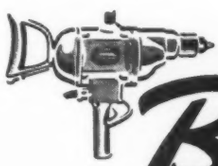


**LECTRO-SHEARS**—speed up sheet metal cutting—either straight-line or intricate pattern work, down to minimum cutting radius of ¾". Cutting operation always visible. 2 sizes—18 and 16 gauge.

**GET IN THE SCRAP WITH YOUR SCRAP**

On aircraft parts, sub-assemblies and assemblies, on aircraft engines, equipment and armament, countless jobs are being done faster today—thanks to the advanced engineering and built-in quality of Black & Decker Portable Electric Tools.

A few of these tools are pictured here. Many more are shown in our new catalog. For a copy of the catalog—and as a dependable, convenient source of supply—phone your near-by Black & Decker Distributor. Or write to: The Black & Decker Mfg. Co., 738 Pennsylvania Avenue, Towson, Maryland.



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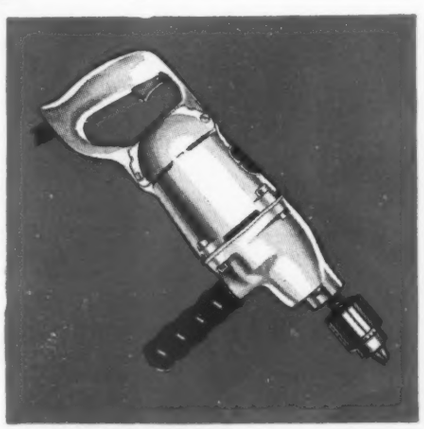
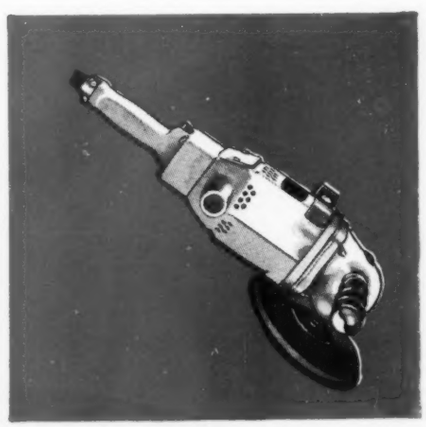
PORTABLE ELECTRIC **TOOLS**



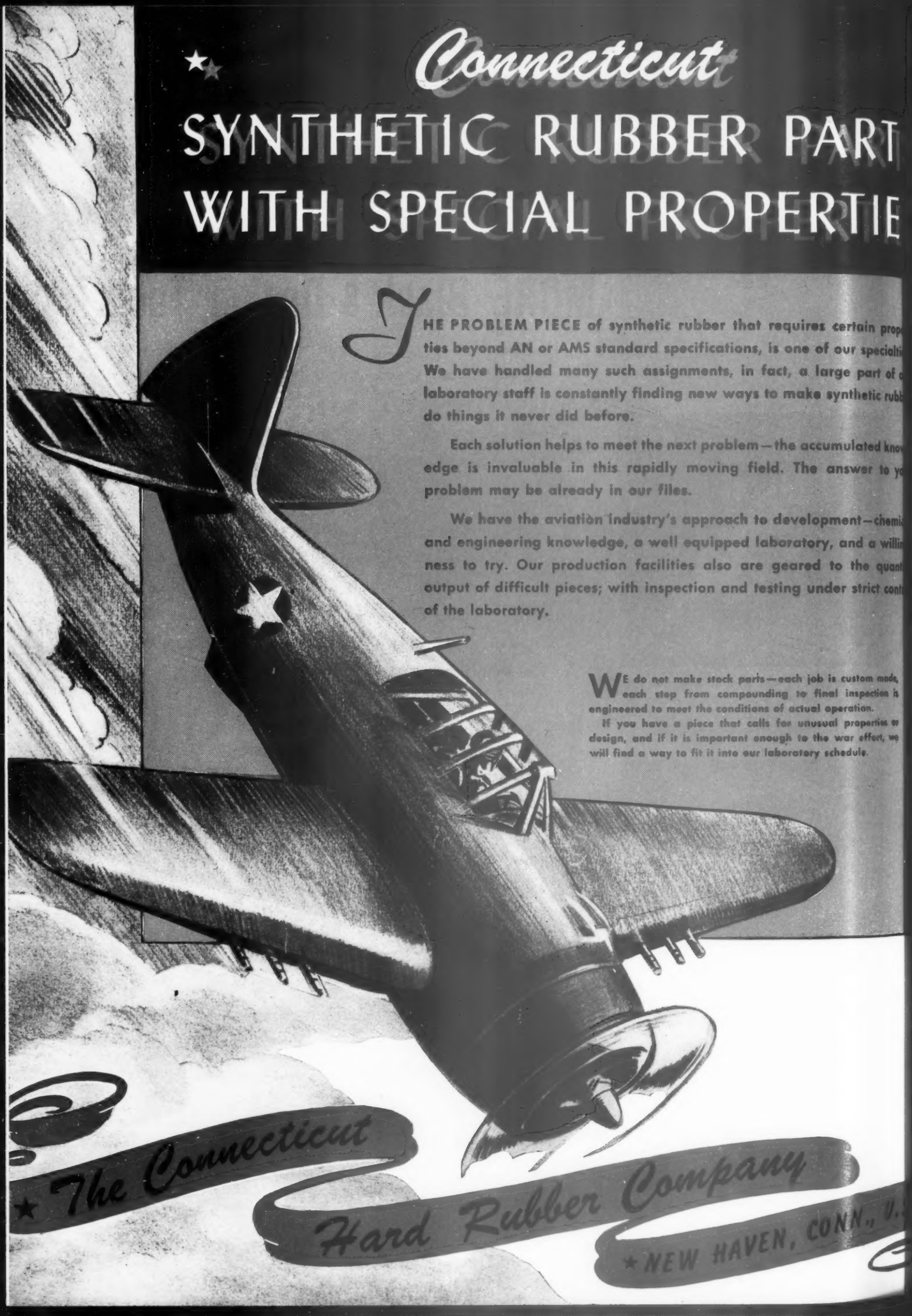
**ELECTRIC TAPPERS**—for hole threading at high speed with less tap breakage. Capacities up to ⅜" in cast iron, ¼" in steel, ½" in brass or aluminum. Reverses automatically. Universal motor.



**ABRASIVE TOOLS**—Sanders, Portable Grinders and Bench Grinders—for smoothing, cleaning, buffing, wire brushing and sharpening operations. . . . on metal, wood or plastics. Vital parts sealed against dust.

# Connecticut

# SYNTHETIC RUBBER PART WITH SPECIAL PROPERTIE



THE PROBLEM PIECE of synthetic rubber that requires certain prop ties beyond AN or AMS standard specifications, is one of our specialti We have handled many such assignments, in fact, a large part of laboratory staff is constantly finding new ways to make synthetic rubb do things it never did before.

Each solution helps to meet the next problem—the accumulated kno edge is invaluable in this rapidly moving field. The answer to y problem may be already in our files.

We have the aviation industry's approach to development—chemi and engineering knowledge, a well equipped laboratory, and a willin ness to try. Our production facilities also are geared to the quant output of difficult pieces; with inspection and testing under strict cont of the laboratory.

WE do not make stock parts—each job is custom made, each step from compounding to final inspection is engineered to meet the conditions of actual operation.

If you have a piece that calls for unusual properties or design, and if it is important enough to the war effort, we will find a way to fit it into our laboratory schedule.

The Connecticut Hard Rubber Company

NEW HAVEN, CONN., U.

# Boosting Bomber Production By Subcontracting

**Glenn L. Martin Company maintains corps of 40 expediters to work with parts and subassembly makers to speed flow of bombers to war fronts.**

By T. J. DUNNION, *Director of Procurement, The Glenn L. Martin Company*

A FEW MONTHS AGO a company in Baltimore was making ice. Today it turns out small assemblies for the Martin 187, an attack bomber that has been giving Marshal Rommel plenty of trouble in Africa and over Malta.

Another concern in Indiana was making, of all things, curled hair. Today it makes seat cushions for the mighty Martin B-26—"the bomber that broke the Japs' hearts at Midway."

A famous Eastern jewelry concern, source of many a costly lavalliere and brooch, now does fine machining for the deadly PBM-3, Martin-built Navy patrol bomber.

These are a few typical examples of the way in which civilian factories—hundreds of them—are helping The Glenn L. Martin Company turn out bombers. Their cooperation has, in effect, added millions of feet of floor area and thousands upon thousands of skilled hands to the space and labor devoted to turning out Martin bombers. Thus a sizeable percentage of the parts that go into our bombers are made by subcontractors. This is in addition to such government-furnished equipment as radios, propellers and motors. It gives a tremendous lift and it helps get fighting planes to fighting men much more quickly than would otherwise be possible.

Here is a typical example of how such a useful association begins:

Not long ago the general manager of a firm in the Midwest called the Martin plant by phone. Priorities had knocked his milk can business into a cocked hat and he wondered if his factory could be useful to us in some way. He had an idea he could convert it into a shop to make wing spars for our bombers. Bombers need a lot of wing spars; we were interested at once. A procurement engineer—we have 40 of them at large roaming the country in search of just such opportunities—went to look over the plant. He found its facilities unsuited to the making of wing spars but ideal for turning out exhaust stacks. Result: Today the milk can factory is furnishing exhaust stacks for such terrors-to-the-Axis as the Martin 187.

This incident is neither unusual nor extreme. Indeed, it is typical of the vast subcontracting experience which this company has built up since it startled the industry in 1939 by apportioning nearly 20 percent of the work on a single bomber type to other concerns by subcontracts. Today, under the terrific pressure of war production, that figure has nearly doubled and has been applied to three types of bombers now being built on a quantity production basis.

Martin's pace-setting step of 1939 provided a good lesson in subcontracting for the even more strenuous times that were to come. France, threatened by swarms of German war planes, turned—although too late—to this country. Martin immediately went to bat by doubling its plant size in 77 days and quadrupling its personnel by a rush-order training program. However, even this was not enough to keep abreast of the unheard-of demand for production of bombers, so the company logically decided to find some means of utilizing the facilities and talents of other industries and plants, large and small, whose business had been curtailed by reason of priorities or other restrictions.

Martin experts surveyed the field, located plants that could handle production jobs, showed them how and put them to work. The company's pro-

(*Turn to page* 223)

*The deadly Martin B-26 bomber, one of three types being built by Martin with the aid of subcontractors whose plants are located in states reaching from coast to coast and up to the Canadian border. Subcontractors account for nearly half of the component parts which roll off the Martin assembly lines as finished aircraft.*

# LYON *Takes to the Air*

## Now Producing Aircraft Parts in ALUMINUM as Well as STEEL

● For more than two years Lyon's resources, facilities and organization have been concentrated on the production of war products. Careful research demonstrated that our experience in the fabrication of sheet metal made it practical to expand our war effort to include production of urgently needed aircraft parts.

Our new Aircraft Division . . . completely equipped, and supervised by foremen specially trained in aircraft plants . . . is now in production. First contracts cover manufacture of Ailerons, Rudders, and Elevators in aluminum, plus Vertical Fins, Stabalizers, Elevators and Carburator Intake Valves made of steel. Check list indicates the types of aircraft parts on which we can offer production help.

We invite your careful investigation of Lyon facilities for helping aircraft manufacturers increase their war production.

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### ✓Check LYON Facilities for Producing

- ✓ 1. Wing Tips
- ✓ 2. Fire Walls
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- ✓ 6. Wing Struts, Framing, etc.
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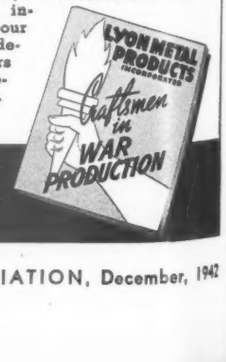
- ✓ 12. Stabilizers
- ✓ 13. Gas Tanks
- ✓ 14. Flaps
- ✓ 15. Ammunition Boxes
- ✓ 16. Installation Flap Doors

Our illustrated book, "Craftsmen in War Production" contains interesting data on our two plants and details of our 43 years of production experience with metal. Write for it.




**LYON METAL PRODUCTS, INCORPORATED**

curement staff still keeps in close touch with these outside concerns and is constantly on the alert to discover more such plants. They help to set up machinery, rearrange factories, locate materials and train personnel.

The result is that today our subcontracting system throws a mighty net of supply lines all over the country. Parts come to the main assembly plants from Connecticut, Wisconsin, Ohio, Iowa, Illinois—even from as far away as California.

Some of the changes in products that the war has wrought would sound amusing if this whole thing weren't so deadly serious. One firm that used to make bottle caps for soft drinks now builds wing spars for the B-26. Another that used to build escalators to save "milady" the trouble of walking upstairs sends mountings for gun turrets, from which American fighting men shoot down Nazis and Japs. A third, in other days a great producer of galoshes and raincoats, makes the famous Martin self-sealing gas tank.

The smoothness and efficiency with which the subcontracting system functions would not, however, be possible without the day-and-night services of the company's staff of expediters who range the country from border to border and coast to coast. The life of an expediter is not an easy one. The only shift this tireless crew knows is getting quickly from one place to another, and it is more or less routine for them to spend most of their nights in airplanes or trains which, under present conditions, is at best difficult.

Jimmy Zimmerman, our chief expediter, tells of a case where one of his men rode inside a carload of steel in order to get to a Midwestern plant so that, in addition to delivering the steel, he could follow it right into the shops and get it onto the machines.

Zimmerman also tells about the case when the final assembly department called him out of bed at three o'clock in the morning to tell him that the flight test would be held up on two patrol bombers which were due for delivery in the morning, because a few specially designed fittings which had been promised had not arrived. Zimmerman immediately phoned the subcontractor, only to be advised instantly that one of his men was right there in the subcontractor's parlor, waiting for him to get dressed so that they could go to the plant and hustle the parts through inspection. Five hours later the parts were being installed on the airplanes, within two hours the bombers had been accepted by the Navy and were on their way to do their bit at some unknown front.

Not only do these men expedite parts and materials but they assist subcontractors with problems on tools, engineering and priorities. Here's a sample job they turned in:

Not many days before the Battle of Midway, we discovered that a certain bomber part, made of aluminum, was not working as well as it should. It was decided to make the part of steel. It just happened that the factory best equipped to do the new job was in a Michigan city, a good distance from the Martin plant. By telephone we asked the aluminum plant to send by fast truck the die needed to make the part. Meanwhile the plant selected for the job didn't have the steel to make the part. The Municipal Airport at Baltimore was asked to hold a plane just about to take off with 14 passengers. The passengers got out of the plane and were replaced by a truckload of steel rushed from our plant.

The die reached the Michigan plant at the same time the steel did and production was started immediately. Planes

*Cooperation of large and small subcontractors has played a vital role in speeding production of the Martin PBM "Mariners" for the Navy. Martin expediters are constantly roaming the country seeking firms capable of producing aircraft parts and working with already established subcontractors to help insure steadily increasing production.*

**Are you interested in: (1) Reducing time and cost of handling tools and materials; (2) Saving floor space; (3) Increasing protection against fire, sabotage and personal injury hazards?**

**This comprehensive catalog contains many suggestions for meeting these war-time problems. It illustrates and describes many types and sizes of shop boxes, work benches, portable tool stands and many other items that manufacturers of Airplanes and Airplane Parts are finding most effective in every production operation.**

Mail coupon today for your copy of this useful book.

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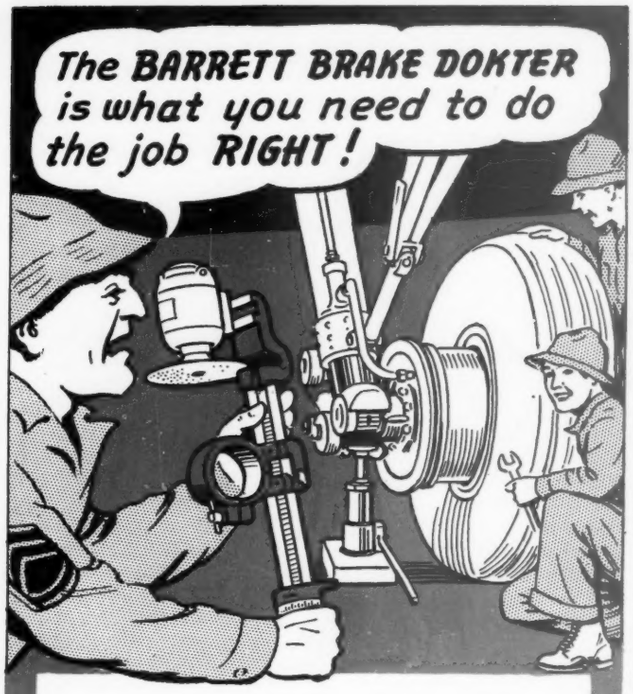



Right you are,— servicing brakes on planes is a "cinch" when you have a Barrett Brake Dokter on the job.

Today, good brakes on aircraft is of paramount importance. Good brakes don't mean a thing when the planes are up in the "blue," but when they land a lot depends on *good* brakes. Terrific landing speeds and high heat temperatures in the drums are hard on brakes, and if the brakes are not properly installed and serviced, damaged ships, injury, and very often fatal accidents result. Keep 'em flying . . . Keep 'em safe . . . Keep brakes in perfect shape with the Barrett Brake Dokter.

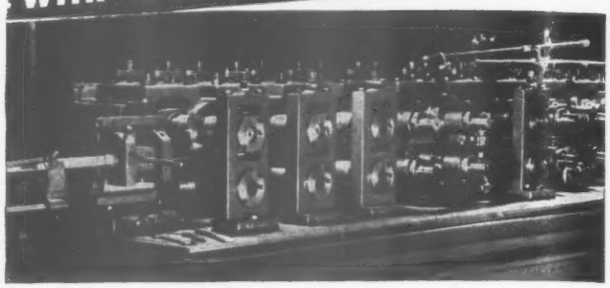
**The BARRETT BRAKE DOKTER**
**is the answer to Precision Brake Service**

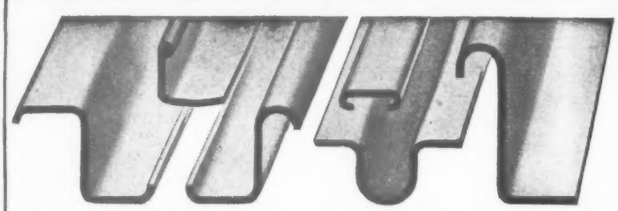
The Barrett Brake Dokter actually grinds the brake shoes to the exact drum size while the brakes are in position on the landing gear. It centralizes and adjusts brake shoes perfectly, removing all high-spots and compensates for warped and distorted backing plates and shoes . . . It is a drum gauge, shoe centralizing tool, lining grinder, caliper and drum-to-shoe clearance gauge all in one.

Barrett Brake Dokters, Lathes and other Barrett Brake Service Tools are being used by the mobile forces of the Army, Navy, Air and Marine Corps, and on the production lines of many factories.

**BARRETT EQUIPMENT CO.**
*World's Finest Brake Service Tools*
2101-07 CASS AVENUE ST. LOUIS, MO.

**Let KINKEAD Roll Vital Metal Sections with their Precision Equipment**





**TYPICAL ROLLED ALUMINUM ALLOY SECTIONS**

***EXPERIENCE!***

For nearly fifteen years, Kinkead has been roll-forming an extensive quality line of channels, edgings, nosings, trim, etc. from aluminum, brass, stainless steel and other metals. Contracts with major aircraft builders for roll-formed structural sections are currently being carried out with full speed and efficiency.

Why not take full advantage now of Kinkead's vast experience, specialized knowledge and expanded manufacturing facilities for your close-tolerance requirements of special channels, angles, stringers, hat sections, Z bars and substitutes for aluminum extrusions.

***ROLLING EQUIPMENT!***

With Kinkead precision-built roll-forming machines and automatic cut offs, aircraft sections can be roll-formed to much closer tolerances than obtainable by many present production methods now employed in the aircraft industry. With Kinkead's high rate of production speed, the ratio of die cost to production becomes negligible. Furthermore, shapes rolled on Kinkead equipment can be designed for required strength only and possess an unusually favorable ratio of strength to weight.

***PRODUCTION FACILITIES!***

Kinkead rolling machines are supervised and operated by precision trained crews of experienced craftsmen working in modern, fireproof quarters. Drilling, punching, buffing and washing equipment, as well as tool and die facilities, are maintained at highest standards. Good shipping facilities assure prompt movement of finished material. Recent equipment additions place Kinkead in a preferred position to handle your requirements as needed.

*We will be glad to provide you with further detailed information regarding our capacity and ability to manufacture rolled sections to your exact specifications.*

**Write . . . Wire . . . Telephone . . . NOW!**

*PLANT OFFICIAL CONTACT: W. S. Kinkead--B. W. Brooks*

**KINKEAD INDUSTRIES**
INCORPORATED
**1609 N. Wolcott Ave., Chicago, Ill.**

kept up a shuttle service between the Martin plant and the Michigan city carrying steel one way and finished parts back for final machining. Three days after the first lot of finished parts left our plant, they were actually in the thick of the Battle of Midway.

Of course, this is not a common occurence, for battles like Midway are not fought every day, but it does give some idea of the speed and pressure under which subcontracting work is handled. In addition, it offers a typical example of the type of cooperation we receive from hundreds of companies that are doing, with us, all they can to help win this war.

How do we set up such valuable connections with outside firms? It happens in various ways. Some of them are great corporations who come to us offering to help; some are great corporations whose help we go after. Some of them are tiny concerns, employing a handful of men or women who see their business about to evaporate through lack of materials. Just as is the case of the big corporations, some of them come to us with offers to help; to others we go with offers of a chance to play their part in the building of Martin bombers.

In any case, the practice of subcontracting has the obvious merit of getting planes into the air faster than if aircraft manufacturers were working alone at the job. And it adds to the roster of men and women in the aircraft plants thousands upon thousands of men and women who are directly helping to get planes to battlefronts throughout the world.

Indeed, cooperation in the war effort is the keynote of the whole plan. Firms which in peacetime turned out hosiery and kitchen stoves and refrigerators and razor blades eagerly help us hold the air front by sending in ammunition chutes, gun cradles and parachute slings. Such products arrive at the Martin plants, edge into their spots on the assembly line and presently are winging aloft wherever our fighting men are engaging the enemy.

Some of our subcontractors have their plants in large cities, others in towns you never even heard of. The dollar value of their output ranges from hundreds to millions. But in all cases the result is simply this:

Through the splendid cooperation of its subcontractors, Martin is today delivering bombers at a rate of speed that is causing, and will continue to cause, the Axis powers no end of worry.

Martin appreciates this cooperation.

## Men and Machinery Available for War Work

Both heavy and light precision tools, together with skilled operators, are available for war work. Prime contractors interested in those listed below should address inquiries to AVIATION, 330 West 42nd St., New York, N.Y., referring to the key number with each item.

132. New Jersey metal fabricating firm, founded in 1883, has two plants with over 200,000 sq.ft. of floor space, offering the following facilities: Five light geared head engine lathes with 10-to 18-in. swing, 0.002-in. tolerance; four similar heavy duties, three of 0.002-in. tolerance and one of 0.004; seven horizontal milling machines, 0.001-in. tolerance; one vertical boring mill, same tolerance; four 0.002-in. tolerance plain radial drilling machines of 6- to 15-in. column; seven uprights of 20- to 30-in. swing, same tolerance; five sensitive single spindles, four of 0.001-in. tolerance and one 0.002; four planers,

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Designers & Manufacturers of
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cowl wells, muffs, air scoops, supercharger housings and other stainless steel portions of engine nacelles . . . for leading prime contractors.
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AIRCRAFT COMPONENTS, Inc. VAN NUYS, CALIF. WICHITA, KANSAS

Christmas Gifts . . .
For
ADOLPH HITLER

Scrawled across the bottom of a packing case leaving our factory doors recently, appeared this inscription:

"To Adolph Hitler — you've earned the kind of Christmas gift this will help to carry to you."

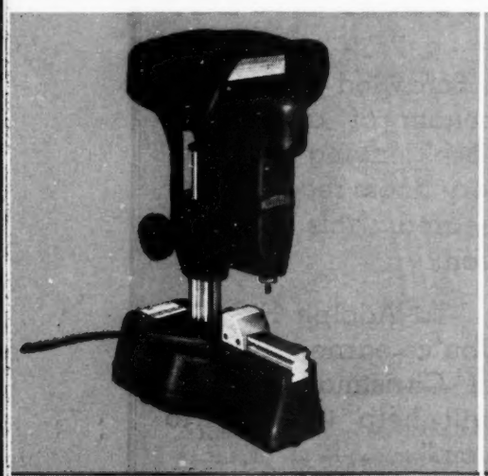
The worker who chalked that message on a shipping case symbolizes the American attitude . . . just one year after Pearl Harbor!

Many other shipping cases are leaving our doors. Hundreds of them. Each is destined for an aircraft assembly line . . . or for a parts replacement center.

Each will help to carry to Adolph Hitler —or one of his Axis partners — the kind of Christmas gift he so richly deserves.

AIRCRAFT MECHANICS, INC.
Colorado Springs Colorado
"The Rockies' Largest Manufacturer of Welded Aircraft Assemblies"

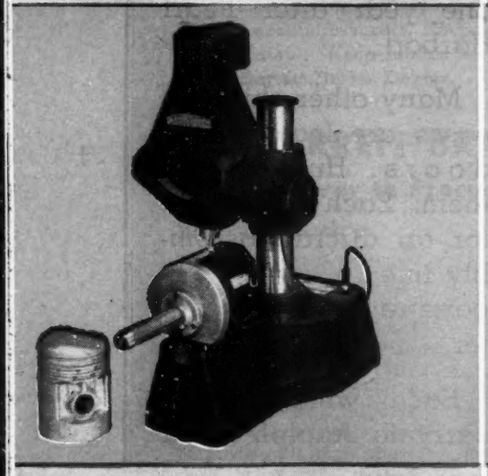
# *Increase* SPEED AND ACCURACY WITH SHEFFIELD PRECISION GAGING INSTRUMENTS



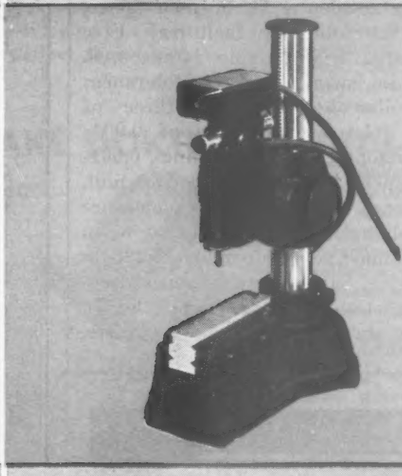
The Visual Gage is available in six magnifications—500, 1000, 2000, 5000, 10000 and 20000 to 1—for checking production and reference gages, work in progress, receiving and final inspection, laboratory and research work. Pitch diameter checked by special attachment.

The Multichek is a combination gage which checks simultaneously a number of critical dimensions, indicating by light signals whether each dimension is within, above or below tolerance limits. A master signal integrates all individual signals for maximum checking speed.

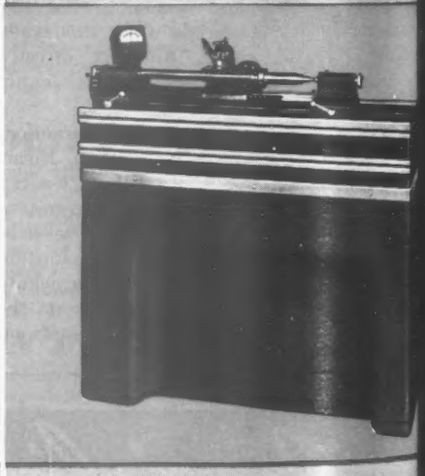
The Precisionaire is an airflow gage for the che ing of internal diameter, taper and out-of-ro on long and/or small bores such as rifle bar and other relatively inaccessible holes. gage may be presented to the work, Mo A, or the work brought to the gage, Mode



The Internalgage checks hole diameter and out-of-round with the same precision as external dimensions are checked on the Visual Gage. It is very advantageous where selective assembly is concerned as in the case of the special piston application illustrated.



The Electrichek is used to show instantly by signal lights whether a dimension is within tolerance, undersize or oversize. It is used as an inspection gage. It can also be mounted on any special fixture desired or directly on a machine to check parts in process or for machine control.



The Thread Measuring Instrument is a co bination electrical and mechanical device checking the lead of screw threads or rack te Precision gage blocks are used as a direct re ence. A Super-Precision Micrometer facilit an accurate set-up and the checking operati

*Descriptive literature available upon request*

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*DAYTON, OHIO, U. S. A.*

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FACTORIES FIND EXTRA VALUE IN

SUSPENDED GAS HEATERS

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Reznor Unit Heaters may be easily and quickly installed — with lower installation costs. This type heating equipment also uses 89% less vital materials than cast radiation systems. You'll find it worth-while to investigate. Write for catalog U 42.

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## Subcontractors Section

two of 0.002-in. tolerance; three shapers, 0.005 tolerance; five saws; four threaders; one threader and one tapping machine plus grinding equipment. Also available are 37 portable arc welders; three transformer type; three radiograph and three pantograph acetylene cutters and five welding positioners; five heating, hardening and stress relieving furnaces and two sandblast rooms. Sheet and plate shops have, among the bending machines, three brake presses, five roll type, one hydraulic flanger and one seam roller; punching machines include four vertical single end, two horizontal single end, three punch, two blanking, three gang punch, six horizontal punching and riveting and one double housing multi-punch; nine shearing machines, including two armor plate shears; and three presses of from 10 to 150 tons.

133. Pennsylvania photo-engraving concern seeks template reproduction, reducing or enlarging scale drawings or making photographic records for filing, offering the following equipment: Process cameras 24x24 in.; dark rooms, vacuum contact frames, routing machines, beveling machines and acid-etching facilities.

134. New York firm, a merger of one which had been in aircraft maintenance and overhaul and sales work for more than 10 years with one of 40-years experience in precision instrument manufacture, seeks subcontracts and offers the following equipment: Six 0.002-in. tolerance engine lathes of from 6-to 16-in. swing; six precision lathes with 0.0005-in. tolerance; two 0.005 and one 0.001-in. tolerance lathes with attachments; a turret lathe with millimeter thread chasing attachment; a power press; a screw machine; a gear cutter; eight drill presses; four saws; four grinders; two shears; a preheating furnace; welding equipment; soldering bench and miscellaneous equipment.

135. Massachusetts research and development laboratory producing medical equipment, already engaged in electronic instrument subcontracting, seeks additional work in the aircraft industry. Equipment includes: Engine lathe; shaper; drill press; jig and circular saws; buffing lathe; grinder; engraving machine; squaring and slitting shears; audio oscillator, 7-70,000 cycles; cathode ray oscillograph; electronic voltmeter; impedance bridge; test sets, meters, communication receivers; and 110-v. d.c. c.v.d.c. 50-cycle a.c. generators.


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Typical small parts produced on GOAT Eyelet Machines . . . small, medium capacity equipment to produce a variety of light drawn and shaped articles required in volume. Handle parts up to .015" x 1½" blank diameter. GOAT specializes in production of stamped, drawn and formed metal parts ranging from .002" to 1/16" metal thickness using all type metals and alloys. Inquiries invited.

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Adolf...here's that bomber—*again.* This hard-boiled baby helped stall your *Wehrmacht* at Dunkerque...and just the other night it was back blasting your ports, hounding your shipping.

Hermann...it's that Hudson your *Luftwaffe* has never really stopped...the ship the R. A. F. calls "Old Boomerang"—because it always comes back.

Hirohito...Tojo's met this Lockheed too, and he'll keep on meeting it...lots of places, and doing lots of things. For the Hudson not only does a job; it invents new ones for itself!

And, boys, it's got a big brother, the Vega Ventura, that has all the family characteristics, and some new tricks of its own! Lockheed Aircraft Corporation...Vega Aircraft Corporation...Burbank, Calif.

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*Lockheed*

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*Member Aircraft War Production Council, Inc.*

# HERE'S SOMETHING TO HELP YOU *Clear the Air*

## HANDBOOK OF SPECIAL STEELS

Newly revised and reprinted—a comprehensive book on the properties, uses, and best methods of handling, treatment, etc. of tool, stainless and other alloy steels. Plenty of tables to facilitate quick reference and selection. 128 pages, pocket-sized, latest data.

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Informative booklets giving clear, detailed data on the various types of tool and stainless steels, their properties and handling. Excellent for training courses in metals and metal-working.

THE lack of information can throw a pretty effective smoke-screen around jobs on the production lines. After all, it's about the same as on the firing line—you can't hit them if you can't see them.

Your plant is probably no exception to the general run of war producers. All have a steady job on their hands of training a stream of new men and apprentices in specialized machine operations or other fabricating procedures. Where the needed information concerns alloy steels, you'll find invaluable the publications listed in the panel to the left.

They're primarily for production men. For engineers and designers, complete and certified technical data on the various types of stainless and tool steels is available in Allegheny Ludlum "Blue Sheets." ● Write for the information or the personal assistance you need.

**Allegheny Ludlum**
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GENERAL OFFICES: PITTSBURGH, PENNSYLVANIA

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# *Yes,* THE HELICOPTERS ARE COMING

THAT'S a fact which has just been brought home to the American public by Igor Sikorsky's recent article in *The Atlantic Monthly,* reprinted in *Reader's Digest,* and by the Sikorsky helicopter pictures in a recent issue of *Life.*

But it wasn't news to Aircooled Motors Corporation, whose Franklin engine powered the original Sikorsky experimental helicopter during its development period.

Whether it's a stock engine for a light plane, power for a helicopter, or designing and building warplane engines for Uncle Sam's Army and Navy (our current job) . . . you can depend on Franklin's 42 years of air-cooled experience to produce fine engines.

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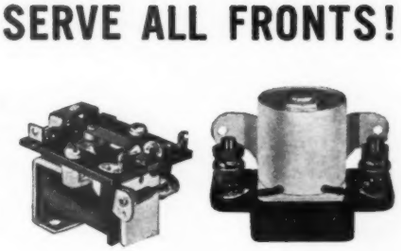
FINE AIRCRAFT ENGINES

# Relays BY GUARDIAN · · · SERVE ALL FRONTS!

★ **Yuletide joys of '42 will not include the many electrical gifts which brought us cheer, and ease, and comfort in other years. Relays by Guardian have marched on from peacetime industry to the firing lines of war. Doing war jobs in many ways . . . in planes . . . in tanks . . . in communications . . . in bomb releases and gun controls. Wartime jobs which Guardian anticipated and planned long before "Pearl Harbor".**

**But, while thinking, building, and engineering the tools of war today, Guardian again is looking *ahead* to peacetime applications of Relays, Solenoids, Electrical Controls of all kinds. If you are making plans for "after-it's-over", ask our engineers to plan with you. Write to Guardian. Our wartime experience can help you build better products for the future.**



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***from the index . . .***

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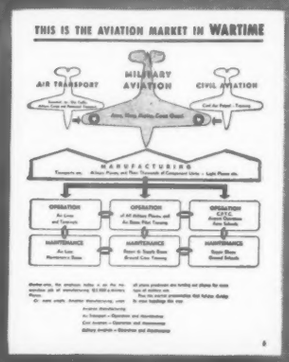


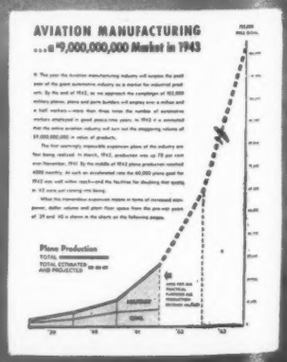

# Aviation Facts Book

## *An up-to-this-minute file of marketing information prepared by the Research Department of Aviation*

WHAT are the facts of today's aviation market? What does the industry buy . . . and what are the sales possibilities for *your* product? Who are the important buying influences to consider in selling and subcontracting to airframe manufacturers, engine builders, parts and equipment suppliers? What is the wartime status of air transport — of civil aviation?

Most challenging question — what are the post-war market potentialities of the aviation industry?

These are some of the questions uppermost in the minds of foresighted business men today. These are a few of the questions this booklet treats *factually* and *objectively*.

We believe this study to be the most informative and up-to-the-minute presentation of aviation market facts obtainable. Within the limits of publishable information it is accurate and unusually comprehensive.

**The method of reaching this market**

Equally as important as *what* comprises the market is *how* that market can be reached.

Thus the latter half of the booklet offers a thorough analysis of *Aviation*, the prime method of sales communication with the executives of the aeronautical field.

Here in concise, readable, easy-to-analyze form is a clear presentation of the editorial policy and purpose of *Aviation*—a demonstration of its daily usefulness to the men who are building our air strength today and who will build our air commerce tomorrow.

Designed for analytical sales executives and advertising buyers, the circulation section of the booklet shows clearly how *Aviation's* circulation thoroughly covers the industry's buying power. How it is directed to the men you must sell, the executives who have the yes-or-no in purchasing decisions in aviation's manufacturing, operating and maintenance divisions—and that important group—the government and military authorities concerned with aviation activities.

**To interested executives, a copy without cost or obligation**

A limited quantity of these booklets is now available to advertising and sales executives. A request on your business letterhead will bring your copy promptly. Address Market Research Division of *Aviation*.

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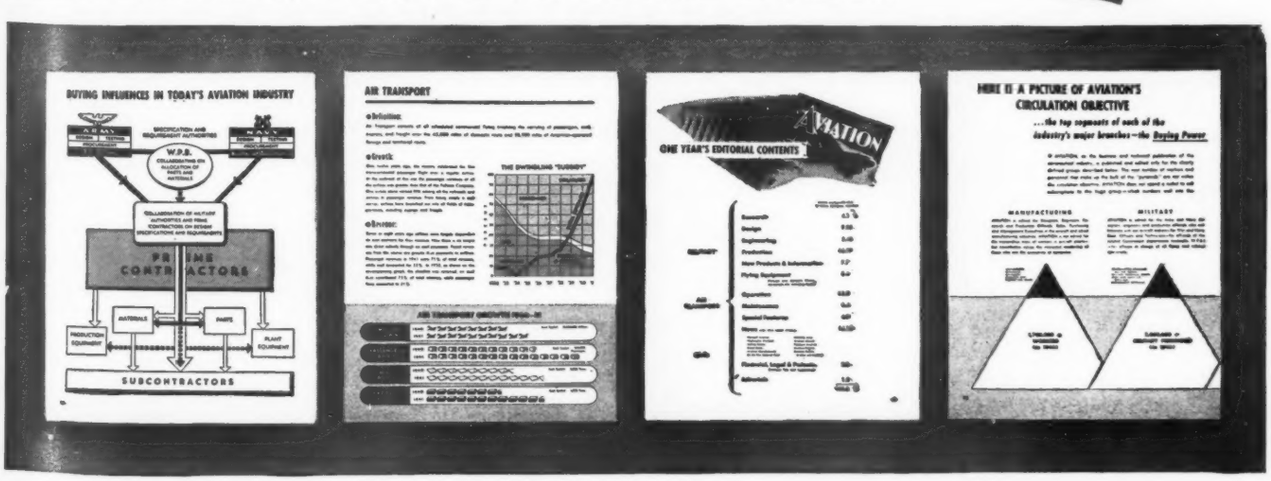

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Countless man-hours of production time and thousands of dollars in original equipment can be saved in almost every instance by coordinating spar design with the mills required for fabrication. Even slight modifications in spar construction can frequently increase production efficiency many fold. Paragon engineers offer you practical experience in this important phase of aircraft production.

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*Airacobra Pilots Going Into Action*

# HEADACHES FOR HITLER—Coming Up!

Over the loud speaker at a distant Allied Air Base comes the warning call "Enemy Aircraft Approaching—Scramble." In trigger-quick response—fighter planes are manned. Then, with deafening roar, a squadron of Army Airacobras takes the air.

Courageous and determined, these Army Air Force Pilots rise to combat, confident that they man the hardest-hitting single-engine fighters in the world. These men deserve the best America can put behind them.

A forward looking Aircraft Industry had sensed for years America's need for fighter planes that would out-fly and out-fight the best the enemy could offer. While ominous war clouds gathered into thunder-heads new plans and planes were under way. Working with our Army Air Force we created the P-39 Army Airacobra. Free from precedent our engineers developed a new design from nose to tail. They put a cannon in the nose—placed the engine behind the pilot—gave it a tricycle landing gear. They made it a powerful weapon designed expressly for the needs of war.

Today these deadly fighter-planes serve Allied forces on fighting fronts around the world.

But some day victory will come. War-trained pilots will return to take their places in a new world of accelerated transportation. America will create new planes to carry on her commerce in the skies.

That day will find Bell Aircraft ready—ready with its engineering skill, assembly lines and trained personnel converted to the pursuits of peace-time aviation. © Bell Aircraft Corporation, Buffalo, New York.

*Airacobras for victory—*

FUTURE PLANES FOR PEACE

**BELL** *Aircraft*

**PACEMAKER OF AVIATION PROGRESS**

*Army's AT-9 Transition Trainer*

*Navy's SNC-1 Advanced Trai*

# ARMY AND [illegible] HEROES OF THE AIR

**SECOND PRINTING:** Send 10¢ for **your** copy of this fascinating 96-page history of aviation by Assen Jordanoff, author of "Your Wings", with illustrations of current fighting types. Airplane Division, Curtiss-Wright Corp., Buffalo, N. Y.

Curtiss-Wright fighters, dive-bombers, observation and military cargo airplanes are conspicuous constantly in the war's headlines. But behind these headlines is another type of Curtiss-Wright ship—the trainer—in which thousands of America's superb fighting pilots today are winning their wings. Twenty-five years of development lie behind these modern training planes—for the world's earliest trainers were the famous "Jennys" of World War I.

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*Corporation*
*AIRPLANE DIVISION*

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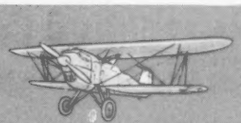
*Since the Birth of Aviation*

**1917**•The world-famous Jenny (JN-4D) of World War I. About 5000 were delivered to the U. S. Army Air Corps and our allies. Maximum speed, 75 m. p. h.



**1927**•The Curtiss Hawk (AT-4) Advanced Trainer. Its 190 H.P. engine gave this ship a high speed of 133 m.p.h.—a cruising speed of 106 m. p. h.

**1929**• The Curtiss Navy Fledgling primary trainer (N2C-1). High speed, 108 m. p. h.; cruising, 87 m. p. h. Powered with a Wright J-5 engine.

**1930**•The Curtiss Army Falcon (BT-4)—a basic trainer with a high speed of 140 m. p. h. and a cruising speed of 112 m. p. h.

• MR. WEBSTER defines an ode as a "lyric poem of exalted style and tone, often of varied or irregular meter."

Even though he grants the leeway of "varied or irregular meter," this department still can't write a lyric poem. But if it were possible, this essay would be titled "Ode to the PBY." And it would tell one of the most heart-warming tales yet to come out of this war of the stamina and versatility of American aircraft and the ingenuity and guts of American airmen. Its climax would tell how a PBY was used to pinch hit as a combination dive and torpedo-bomber, blazing out of a sky full of *Zeros* to sink a Jap troop transport at a crucial hour in the defense of Guadalcanal.

First, though, this ode would relate how the PBY was designed and built way back in the early '30's as a long-range patrol bomber. It would tell of the excitement created when a group of them were flown in formation from the West Coast to their bases in Hawaii, and later from the West Coast to the Panama Canal Zone, an even more breath-taking feat. Such deliveries were feats in those days, even though the Navy always called them "routine deliveries."

• It would record, too, that a PBY—called the *Catalina* by the British—found and stalked the *Bismarck,* pride of the Nazi fleet. That was work for which the PBY had been built—spotting the enemy and keeping him under surveillance till surface units could be guided in for the kill.

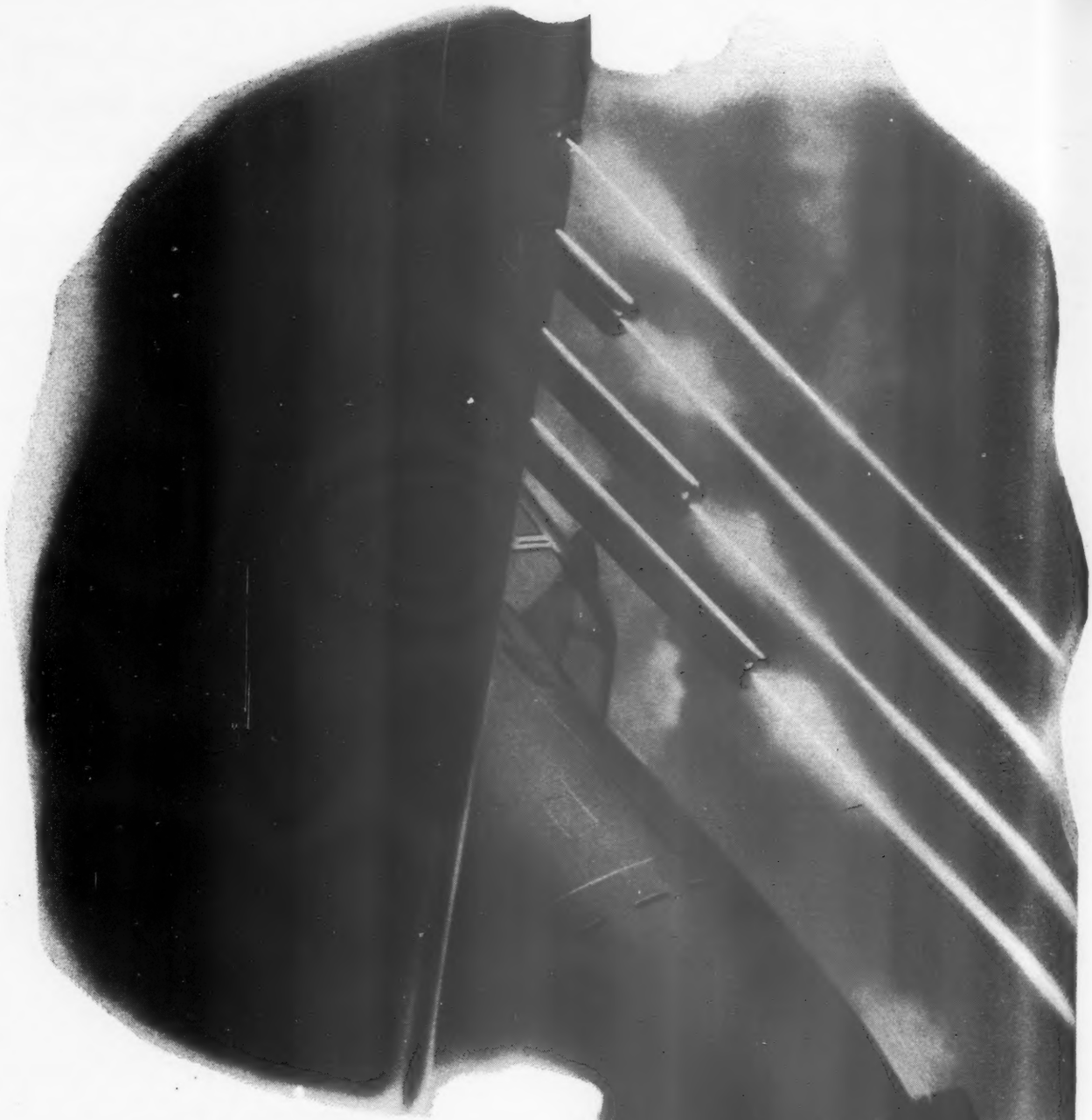
Drudgery would not be overlooked, for the ode would tell of the long, grinding hours PBY's and their crews put in on war transport work. No heroics, no medals, no headlines—just back-breaking work that is such a large part of war, but without which no victories can be won. Nor could it ignore the hours—just as long and grinding—of reconnaissance, looking for enemy fleet units. And how, when Jap carriers with their nimble fighters were spotted, the PBY crews would radio the location and add laconically, "advise next of kin" because they were there to stay and fight as long as they could.

• THEN THE ODE would speak of Guadalcanal, to tell of a critical hour in its defense. For, in broad daylight the Japs were unloading troops from ocean-going transports. Something, to put it mildly, had to be done. The general wanted a torpedo plane. He got it. A PBY, a patrol bomber, was converted to a TB job. Meanwhile Marine Maj. Jack Cram was asking questions for, you see, he'd never done any torpedoing before. And his crew had never fired their guns in combat. But when that PBY and her torpedo load took off, Crew Chief Adam Metz; Engineer Darrel Anderson; Radiomen Albert Hoffman and Richard Horton, and Gunner Robert Kirby, were at their posts. There wasn't any co-pilot.

In breath taking words the ode would describe their climb into the sky, where 15 Jap Zeroes waited to blast them; it would tell how that crew got its baptism of fire; it would describe Maj. Cram's feelings as he stuck the plane's nose down and watched the air speed indicator go off the dial, way beyond any speed for which the craft had been built. And it would tell how that good old PBY, with bullet holes from nose to tail, kept her wings on and stayed in one piece as Cram pulled out of that screaming dive at 75 ft. to loose the torpedoes to sink that Jap transport, and how, because of its inherent strength, it brought its crew back to fight another day or, perhaps to grinding hours of patrol or transport work.

That ode would make a lot of Consolidated workers proud of all the PBY's they've built; it would make a lot of Americans proud of the men who fly them.

*"Maguire couldn't get a priority order for a new flying suit."*



***WHEN A THUNDERBOLT STRIKES*** . . . Eight deadly streams of steel-jacketed metal spurt from the wing batteries of a *Republic P-47 Thunderbolt* with an impact guaranteed to tear apart any Swastika'd Hun or ruddy Rising Sun that dares fly within range.

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REPUBLIC AVIATION CORPORATION — FARMINGDALE, L. I., NEW YORK

# How Our Navy Gears Pilots For War

**In revolutionary four-phase system, each cadet gets solid year of training, amasses nearly 300 hours. Meantime, Navy's new scientific methods have brought "bilge outs" down to an all-time low.**

By LIEUT. (jg.) FRED TUPPER, JR.

FROM CORAL SEA to Midway, from the Aleutians to all Seven Seas, every dogfight, bombing attack, and patrol mission is putting a new heavy accent on the tremendous importance of naval air power. And meantime, while aircraft carriers thread through the mine-infested Mediterranean and waters across the Pacific to disgorge their umbrellas of planes, our Navy is also multiplying its aero efforts ashore.

Torpedo bombers and scouts, fighters and patrol planes are rolling in ever increasing quantity from stepped-up assembly lines. Dozens of carriers—counting the converted merchantmen—are being readied for action. Land-based fighters are joining the swelling air armada.

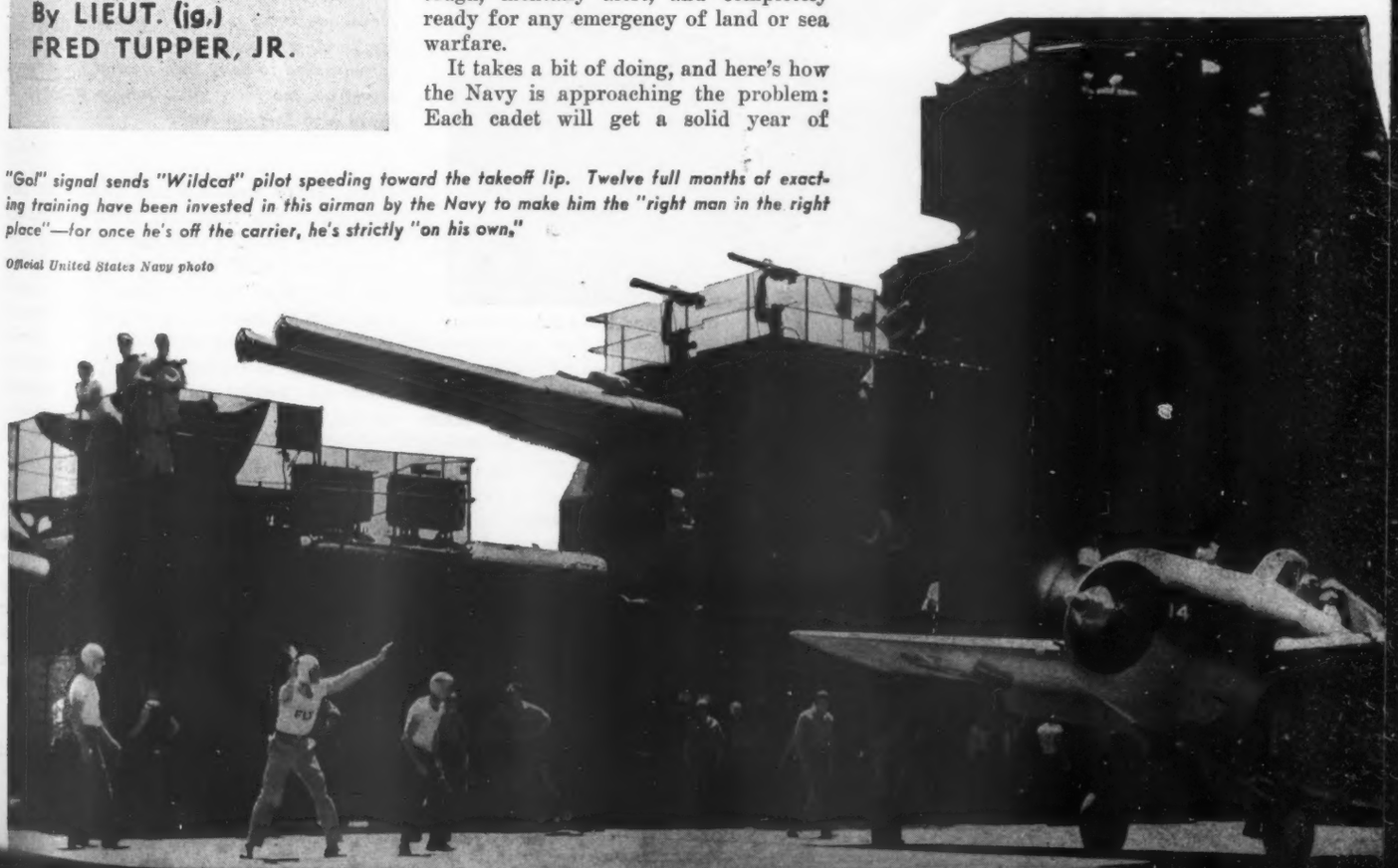
To keep pace, a vast new body of Navy pilots—30,000 strong—is training at air bases from Canada to the Gulf. Who is eligible to fly? Any young man between 18 and 27 who has a high school diploma (the two-years-of-college restriction is now "out") can "make it" if he is physically fit and can pass a "screening" test. To prepare these men, the Navy has introduced a revolutionary new type of training program designed not only to produce the best pilots in the world but to make them physically tough, mentally alert, and completely ready for any emergency of land or sea warfare.

It takes a bit of doing, and here's how the Navy is approaching the problem: Each cadet will get a solid year of training. The Navy will spend up to $27,000 on him personally, will guarantee that he'll get nearly 300 flying hours under his safety belt before he joins the fleet.

Training is split up into four phases, each of approximately three months duration. First, the cadet will attend a pre-flight school (each one is an "Annapolis of the Air") at one of four universities—at Athens, Ga., Chapel Hill, N.C., Iowa City, Iowa, or St. Mary's, Calif. Then, at one of a score of strategically scattered naval reserve bases, he will learn to fly in primary trainers.

Next step is advanced training at one of the huge naval intermediate centers, at Corpus Christi, Tex., or Pensacola, Fla. And finally, commissioned an ensign in the Naval Reserve or a second lieutenant in the Marine Corps, each pilot will have a course in operational training in combat or patrol craft before being assigned to active duty.

In cases where those applying at Naval Cadet Selection Boards cannot be sent immediately to pre-flight schools, there is even additional preliminary training. The Navy has arranged with the CAA for 8-week full time and 16-



*"Go!" signal sends "Wildcat" pilot speeding toward the takeoff lip. Twelve full months of exacting training have been invested in this airman by the Navy to make him the "right man in the right place"—for once he's off the carrier, he's strictly "on his own."*

*Official United States Navy photo*

*Official United States Navy photo, International News*

*Above: Grummans off for combat! Pilots have been trained to strike hard, and today 30,000 more Navy airmen are being carefully groomed at air bases from Canada to the Gulf—to multiply those blows into a victory crescendo.*

*Below: Masterful skill must be exercised by carrier pilot following completion of his mission. To find comparatively tiny mother ship on vast expanse of ocean calls for most precise navigation, and to set plane down on narrow flat-top demands faultless command of plane. Perspectives in accompanying photo of Douglas dive bomber over its carrier quickly indicate difficulties of both techniques.*

*International News photo*

*Official United States Navy photo*

*Command "Prepare to launch planes!" sends carrier crew into action "unlimbering" Douglas dive bombers. Thousands more Navy warplanes are being rushed off stepped-up assembly lines, and many new carriers are being commissioned to hurry them against the enemy. Meantime, the Navy pilot training program is keyed high to keep pace.*

week extra-curricular CPT courses for Naval Reserve backlog. The CAA plans to train more than 20,000 of these men annually under the new set-up.

With such preliminaries, the cadet will represent a much better investment as a potential pilot. He will have an opportunity, long before he flies a Navy plane, to find out whether he has any aptitude for flying. He will be physically and mentally prepared for the rigors of modern warfare.

Attrition long has been the curse of pilot training. As recently as two years ago, trainee failures cost the Navy more than $3,500 for each cadet. However, with the introduction of CPT and preflight training, naval aviation expects that more than three-fourths of its cadets—roughly 23,000 a year—will become commissioned pilots. Meanwhile, cadets that "bilge out" have the opportunity to enter other branches of the service.

Navy flying has a specialized technique all its own. To be sure, differences from Army practice are minor in the primary flying training. Both the Army and Navy use the biplane (painted yellow in both services) almost universally; for the "bipe" is considered the soundest training machine for fundamentals. And both services stress the early drills in taxiing, tail-down landings, coordinated air work, and simulated emergencies.

However, while the Navy uses the elliptical pattern for precision landings, the Army stresses the triangular . . . the Navy does wingovers without pattern, the Army traces the nose in a figure-8. . . the Navy gives three checks before solo, the Army allows a cadet to take a plane out after his instructor gives him thumbs up. Still, the eventual result is the same—the cadets learn every trick in the flying book.

But the Navy points its training in a completely different direction. To catapult off a cruiser or battleship, to circle in for a carrier deck landing on a space just 60 ft. wide, to bring a seaplane down in a precision landing in a "slick"—these practices have no parallel in Army or civilian flying.

After a naval cadet has soloed successfully, he runs the gamut of aviation lore. He learns how to "slip" into a landing, how to do flipper turns, wingovers, spirals, and how to "shoot" 100 ft. circles. Simulated emergencies are periodic during primary instruction. The student must master small-field procedure and slips to the best possible advantage. All this will pay dividends later on.

These students literally "get the works." A Coney Island roller-coaster was never like this. They loop, snap roll to the right and left, master Immelmanns, split S's, and falling leaves. They learn precision spins and half-S turns to circles, and finally, there are demonstrations of the inverted spin and its recovery, toughest bugaboo of primary flying. From that day on, they fly from the front seat, then progress to intermediate training at Corpus and Pensacola.

By this time each cadet has had up to 80 hours in the air. Now he flies the advanced trainer—the SNJ—a heavier service-type plane, and he receives more formation work.

But the picture is not complete without ground school. Throughout the course, cadets receive exhaustive ground school instruction, thoroughly learning about planes from prop to tail. There are drills in powerplants, photography, gunnery, aerology, structures, navigation, and communication, more or less in that order—a comprehensive store of knowledge that must be mastered completely.

Each cadet must know how to put an engine together, to fire a machine gun, to analyze a weather report, and to map his course by the stars. Emergencies being the daily diets of modern warfare, a Navy pilot must be the "right man in the right place." For once he takes off from a carrier, he's strictly on his own.

At this advanced-training stage of his development, the cadet is granted the opportunity of requesting the type of duty he would prefer when he is assigned to the fleet. He may also ask for a specific geographic location, depending upon war strategy. Whenever possible, these bids are granted.

"Shore duty in Japan," read one recent request. Whereupon the Navy quickly replied: "Recommended approval—as soon as a shore base is established there!"

What finally happens is this: A student is given one of three assignments—carrier duty, which means flying fighters, scouting planes, or dive and torpedo bombers. . . battleship or cruiser duty, which involves flying catapulted seaplanes and being the "eyes of the fleet". . . or patrol duty in the giant flying boats which reconnoiter thousands of miles of sea.

Consider carrier duty. The day will come—sometime, somewhere at sea—when today's cadet will hear the brusque order, "Man your planes!" He will roar down the deck and take off, easy enough for an experienced pilot. But landing is a different story entirely. In the first place, finding a floating carrier upon return from a battle mission calls for a special technique in itself, based on thorough navigation training and flying experience. To set his plane down on the waving, teakwood surface is comparable to landing on a dime.

There were those Japs, for example, who hadn't quite learned the "trip home" technique. Returning from a patrol mission in the Coral Sea engagement, they attempted to flutter down on an *American* carrier deck. Anti-aircraft blasts quickly corrected their mistake.

To Navy pilots, takeoffs and landings are but minor phases in the over-all problem of flying a carrier-based plane. They must know the procedures of torpedo and dive-bombing, whole studies involving angles of approach, coordination of plane personnel, and methods of attack. They must learn similar and parallel duties for fighters and scouts. Every lesson correctly learned may mean American lives saved, surely promises to mean just the opposite for Japs and Nazis.

One of the trickiest operations known to naval aviation is detail aboard a battleship or cruiser. That means catapults. Sticks must be held all the way back on takeoffs, since the launching device hurtles the seaplane from a dead standstill to more than a 60 mph. speed before one can say "tachometer."

Landings on the water must be fully stalled, perhaps on a "slick" in heavy seas. These are precision landings—plus! The seaplane waits for the battleship or cruiser to turn, then sets down on the smooth water inside the turn (the "slick") near enough to the ship to permit a "east" recovery. It's that, frankly—or else. The fleet hasn't time to wait for planes that miss. Nor can the planes themselves get off the sea during heavy weather.

A patrol bomber, again, is still another breed of cat. And a big one. These modern battleships of the air, powered with from two to four engines, are capable of flying great distances non-stop. As dreadnaughts of the air arm, they carry heavy loads of torpedoes, bombs, and mines. They are "flying households," complete with bunks,

(*Turn to page* 311)

*Right: Precision, then performance! Seven Jap fighters were downed by Lieut. (jg) John A. Lappla, USNR (left), and ARM 3c John Liska, USN. Lieut. Lappla got four, Liska three.*

*Knack of takeoffs from the "jarring cradle" is first learned on dock catapult (which can't roll) aimed over calm waters. These advanced students, preparing for battleship or cruiser details, were "stopped" by camera in split second of their launching in Vought-Sikorsky OS2U-2.*

*Official United States Navy photo*

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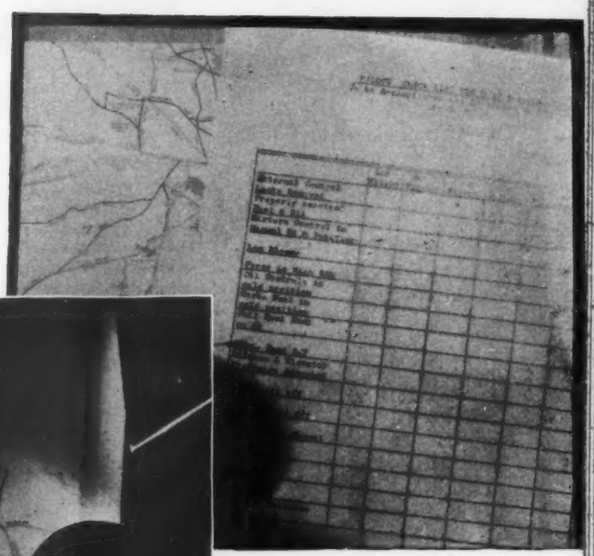

*Fluorescent treated plastic "envelopes," together with near-ultraviolet rays, make it possible to read ordinary printed matter such as orders or pilot check charts or maps and photographs without destroying night vision. It also eliminates the need for "blackout quarters" in a plane, since the so-called black light would be invisible to attacking aircraft. Material in the envelopes can also be used under ordinary white light or in daylight, as is shown at right.*

# Black Light For Night Flight

**Near-ultraviolet ray unit designed to protect night adaptation of bomber crews with flexibility essential to efficient operation.**

THE PROBLEM OF MAINTAINING night vision of bomber crews while still permitting them to read and write orders, study maps, photographs or other printed material appears headed for solution through new developments in combining near-ultraviolet rays and fluorescent treated transparent plastics in the red end of the spectrum.

Exhaustive tests have shown that from 30 to 45 min. are required to completely adapt eyes to cone vision in darkness, but that only a flash of white, or ordinary light, can destroy the adaptation. Thus a bombardier, trying to study photographs to check landmarks during the approach to the objective must avoid the use of white light. Similarly, a navigator attempting to study maps or to make last-minute computations to bring the plane over its objective is at a distinct disadvantage if it becomes necessary to man a gun against defending fighter aircraft.

Thus far the use of black light fluorescent rays has been largely confined to illumination of instrument panels. Recently, however, a further step has been taken by J. M. Gordon, fluorescent and luminescent products consultant. He has developed transparent plastic "envelopes" in which ordinary printed matter, maps or photographs may be read by black light. Carrying the step to its logical conclusion, Gordon has developed lightweight portable lamps which can be placed on a navigator's table or which could be placed on the forehead as are miner's lamps.

In operation the unit, producing a low intensity of unseen near-ultra-violet light directed over an orange-red fluorescent treated transparent plastic, emits a minimum light glow sufficient for vision of descriptive material under the plastic surface. The glow is produced by bombardment of invisible near - ultraviolet shortwave impulses in the 3,600 angstrom unit range which accelerate molecular surface tension of the fluorescent material into longer wave length energy, re-emitted as visible light, in the 4,000 angstrom unit range.

The Gordon portable unit, comprised of a self contained 2½-w. near-ultraviolet light source or the 4-w. 24-28 v. black light source standardized by both the Army and Navy, when placed 5 in. above the fluorescent surface will permit vision over a 36-sq.in. area.

The "envelopes" employed by the Gordon process can be used either to hold —and make visible—charts, orders, photographs or maps or penciled messages can be written directly on them and erased later for re-use. Provisions for use of the Gordon envelopes have been designed into a new bomber, production for which is under way, and are currently being used by the Signal Corps. The envelopes can be made up in practically any size desired—from small card holders through standard letterhead size up to map or chart cases, and for plotting operations.

# Developing Wider Cargo Markets

*Photos courtesy Pan American Airways*

***Vastly increased movement of both cargo and passengers due to wartime pressure is giving America's airlines a vast wealth of "know-how" which will be invaluable for postwar developments. Nevertheless "selling the service"—on which they have done an excellent job—will assume greater importance than ever in developing the large cargo business which will be one of the outstanding post-war developments.***

## Postwar growth of "Airex" commodity list presents a series of merchandising problems involving both designer and operator to give air transport a dominant position.

**By ROBERT K. KINZEL**

PRIOR TO PEARL HARBOR the true large-scale movement of cargo by air was still in the realm of the future. It is true, of course, that the airlines had made a start in this direction through a sound gradual development. It is also true that several outstanding jobs on heavy cargo movement had been developed such as transporting mining machinery into the Andes, Alaska and other remote regions, and hauling chicle from Guatamalan jungles.

But aside from these special geographic conditions, the railroads, trucks and steamships had been virtually unchallenged, as is shown by the fact that the domestic airlines in 1940 moved less than 1 percent of the total air express business of approximately $200,000,000 in the United States, not including the large volume of express moved by truck.

Dec. 7 was the start of a new era, because from that day many heretofore unsolved air freight traffic problems disappeared. There was only one thought —how much can be moved by air and how fast can we get it there. Cost, convenience of shipping, ground handling and other questions were put aside. The government immediately started large movement of urgently needed goods. Steamer space became scarce, war risk insurance premium rates rose and there was always the hazard of badly needed merchandise being sunk.

This radical change ended the period of gradual and progressive increase of commercial business which the airlines had been enjoying, but it gave them advantages which more than compensated for this loss. Commercial business which was lost was only temporary and will come back in greater volume after the war.

In the meantime the airlines are acquiring in a short period of time a wealth of experience in the mechanics of flying freight, not only in the United States but throughout the world. Personnel is being trained in all phases from ground handling, routing and loading to accounting. Cost figures of actual operations are being assembled. That all essential "know how" is being obtained without the usual business risks. No one has to guess whether or

not business can be obtained, no one has to estimate costs, to shave prices to meet competition. The end of the war will see the airlines with a large reserve of experienced personnel available. Cargo planes should be abundant and the manufacturers will be vying with one another to produce even more efficient planes.

Despite many predictions arising from the recent cargo plane controversy, which generated more heat than light, the airplane will not put the steamship, railroad and truck out of business. Air men are generally agreed that heavy freight such as coal, grains, cattle, steel and ores are not to be considered yet—and that "yet" is important because we are already hearing predictions of "flying boxcars," "air trains" and "freighters with wings."

A new word has been needed to define the type of shipment which will travel by air tomorrow. "Air freight" is a misnomer. Rather let us call it *Airex*, because the nature of the shipments by air in the future is still somewhat of an unknown quantity. It will, however, embrace a large and heterogeneous group of commodities moving at air speed which previously moved, sometimes by express, sometimes as LCL and even sometimes as carload or steamer freight tonnage. It must include products to and from new markets which could not be tapped by surface transportation. Although not along the lines customarily known today as freight, aircraft will move a large group of commodities in ever increasing volume—in volume perhaps larger than the more voluble boosters of "air freight" believe possible.

Further discussion of the problems determining the scope of *Airex* shipments can be best presented against a brief review of the experience to date. The air express business built up before the war was definitely limited to a few commodity groups because of the transportation cost, which averaged 80c. per ton-mile in the United States and slightly more in international trade. Foremost of these groups comprised perishables such as news, newsreels, advertising material, flowers, biologicals and some style articles such as women's clothing. The second group included machinery replacement parts which were urgently needed and for which the transportation costs were unimportant compared with payroll and production losses. Thousands of dollars could be saved by getting a repair part to a closed plant in Buenos Aires in a few days instead of in a few weeks.

Third came samples and duplicate papers which could be moved with little or no loss in time as compared with airmail, but with large savings in cost. One manufacturer of neckties regularly sent silk samples all over South America and across the Pacific as far as the Philippines and Singapore. By this method he was able to get his foreign orders in time to manufacture them at the same time as his domestic ties, resulting in a saving of many times the cost of air transport. An additional advantage, he reported, was the fact that his air express packages got prompt attention from the buyers, giving him an advantage over competitors who used surface transportation.

The fourth, or miscellaneous, group included many emergency items ranging all the way from false teeth and eye glasses to such things as an asbestos suit needed to put out an oil well fire.

The steady, healthy increase in the amount of air express carried each year was the result of good management and improved operations through which more and more shippers became aware of the service. There were many in the industry, however, who were convinced that this high-priced, super-speed service would continue to be restricted to a negligible portion of the available ex-

*As "Airex" commodity shipments gain in size and volume new types of cargo handling equipment will be needed to meet varied requirements imposed by geographic conditions. The greatest possible degree of standardization will be necessary for utmost efficiency.*

*Use of land-based aircraft in international trade—already given tremendous impetus by exigencies of the war—means not only vast savings in time, but in the amount of handling between point of origin and destination. These savings can be converted into dollars and cents to help bring air cargo costs down to competitive levels.*

press business—to say nothing of freight—unless costs were radically reduced and an efficient system of ground handling and transfer was set up.

Although employing a new medium, the movement of goods by air can and must be considered a series of merchandising problems, of which the first is price, unless the factor of heavy government subsidy enters the picture. Just as the automobile was a vehicle for the few when its price was in thousands of dollars, so the airplane remains a vehicle for the smallest percentage of shippers while its ton-mile cost remains about four times as high as its nearest competitor—express by rail or truck.

As in any other merchandising problem it is axiomatic that the lower the cost the larger will be the volume. The present transportation price-volume structure can be generally compared to a pyramid, with today's air express rate of 80c. a ton-mile at the apex. Farther down but with greater volume is rail and truck express averaging slightly under a 22c. per ton-mile cost from whence the pyramid broadens to a base of carload freight and steamer tonnage, ranging from 5c. to less than 1c. per ton-mile.

Such a picture readily points the way to the initial postwar step in air cargo transportation. At first glance this might seem a formidable step—to lower rates sufficiently to compete with services whose charges are one-quarter or less of present day air transport charges. But such a reduction is not a matter for visionary speculation as something possible, say in 20 years. It is a distinct possibility to be put into effect as soon after the war as commercial aviation, as such, is resumed.

It is within the realm of possibility, using today's equipment, to come within a few cents per ton-mile of current rail or truck express rates. This is shown by the fact that cargo planes have been built—and are in service—which can be operated for approximately 5c. per ton-mile of payload, and on which a conservative 100 percent can be added for overhead, which includes interest on investment, administration and ground maintenance. Naturally, overhead will not increase in proportion to volume of goods carried. Again, conservatively figure on but a 70 percent load factor and the operating and overhead costs total about 14c. per ton-mile, to which must be added pickup and delivery costs. These latter costs, to be discussed in more detail later, will vary with the amount of service rendered, but it is not unreasonable—on the basis of previous experience—to assume that they will not exceed 10c. per ton-mile. One basis for such a conclusion is the fact that express pickup and delivery is rendered by both railroads and trucks as part of their service whose over-all cost to the shipper is 22c. or less per ton-mile.

*Already air transportation has made great progress in expanding its cargo activities beyond the highly publicized emergency and luxury shipments. In Colombia, for example, today's regular tariff rate includes items ranging from fresh vegetables through jerked beef to school textbooks.*

*The airlines need not be content with merely attempting to get a large portion of the world's express business, the author believes, since there are several factors which, with proper commodity analysis, will enable them to carry everyday necessities now moving by other means.*

### Rate Structure

Even though the airlines will be in a position to compete for the express business they face a huge problem in setting up a rate structure. Large international airlines will have many more ports of call than a steamship company has, and in the United States the stops will be comparable to our railroad system. The complicated railroad and steamship structure, about which many books have been written, has been slowly worked out over a period of years through trial and error, convenience, necessity and competition. However, the airlines, even though they borrow many parts of the theory from other means of transportation, must establish their own structure based on the cardinal principals of mileage flown, equipment used, nature of terrain, estimated percent of payload capacity, and competition, the first three being determining factors in cost of operation.

Using the above principles, and by diligent study of the voluminous rail and steamer tariffs, a basic rate struc-

(*Turn to page* 305)

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# Aviation's Future Trends

By SELIG ALTSCHUL

AIR TRANSPORT EQUITIES have reached new highs in popularity recently. This is partly a reflection of the sustained volume operations being experienced by the air carriers and the expectations that record earnings will be established this year. The greater impetus to rising prices for airline stocks, however, is found in the glowing projections which have become so popularly associated with the industry's future.

Examining the short-term outlook, it appears fairly certain by now that the domestic air carriers will handle almost as much, if not more, commercial business for 1942 than they did a year ago —despite operating with about only one-half the number of planes the greater part of the year as were formerly available.

Sustained and heavy volume in all departments—passenger, mail and express—permitted intensive utilization of available equipment and made for profitable operations. Earnings have have been further bolstered by the elimination of the special discounts on scrip and round-trips. "Other income" from war work will also be a major factor in 1942 earnings' reports. In the aggregate, it seems reasonable to assume, in the absence of complete interim reports due to military censorship, that the domestic air carriers will exceed 1941's net earnings of about $3,600,000 by a wide margin and surpass the previous record profits of $4,250,000 shown for 1940.

### Future Being Discounted

It is more than current earnings, however, which are responsible for air transport securities establishing new highs for the year and displaying the best market performance among the various groups. (See accompanying averages and chart.) Many investors and speculators are trying to peer beyond the present and profess to see a tremendous expansion in commercial aviation in the postwar period.

There can be no denying that the airlines will experience a major growth trend and submit to an enormous increase in volume of business. However, translating this volume to net earnings remains to be seen.

The case history of the electric power industry clearly reveals that a substantial increase in volume operations does not necessarily carry through to net income. The electric utilities are highly comparable to the airlines. Strong growth trends are characteristics of the two groups. Both industries are vested with a heavy public interest and are regulated by federal agencies.

According to the Federal Power Commission, the output of electric power more than doubled from 82.3 billion kwh. in 1932 to 168 billion kwh. in 1941. At the same time, a compilation of virtually all of the country's electric utility companies shows that net earnings available for dividends amounted to about $317,000,000 for 1932 and declined to $303,000,000 in 1941. In other words, during this ten year period, while volume more than doubled, net earnings actually declined.

Why this decline in profits in the face of such a substantial gain in volume? It is true higher operating costs and increased taxes were factors, but the major elements responsible were the consistent reduction in rates charged the public for electric power.

(*Turn to page* 302)

**TABLE I—NET WORTH AND RETURN ON CAPITAL**

*Five Major Airlines*

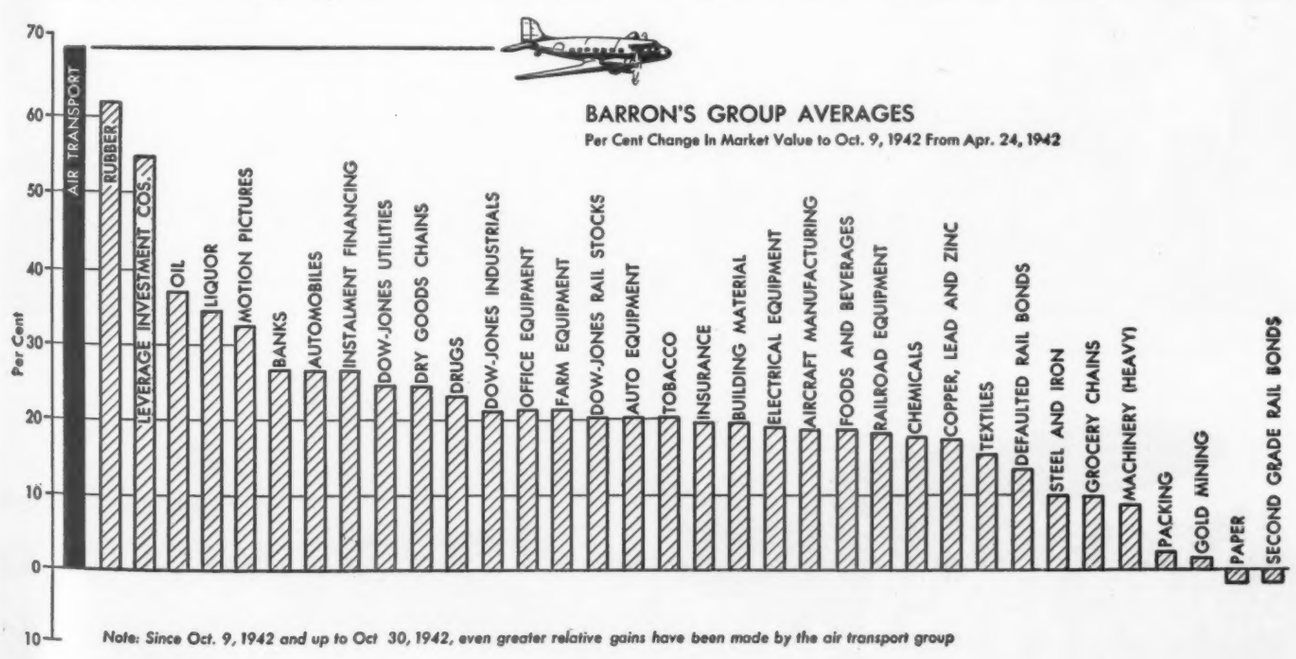
| | Net Worth Dec. 31, 1941 | Net Worth Per Common Share Dec. 31, 1941 | 10% Return Per Common Share 1941 | Actual 1941 Earnings Per Share |
|---|---|---|---|---|
| American | $15,308,008 | $18.00 | $1.80 | $3.93 |
| Eastern | 10,707,244 | 18.70 | 1.87 | 2.81 |
| Northwest (a) | 2,318,848 | 8.79 | .88 | 1.83 |
| TWA | 7,741,730 | 8.12 | .81 | .51 (b) |
| United | 14,027,719 | 9.33 | .93 | .40 |

Notes: (a) For year ended June 30, 1942.
(b) Deficit.

**BARRON'S STOCK AVERAGES**

| | Aircraft | Air Transport | 50 Stocks |
|---|---|---|---|
| Oct. 30, 1942 | 32.20 | 24.09 | 66 |
| Oct. 23, 1942 | 32.95 | 24.97* | 66 |
| Oct. 16, 1942 | 32.38 | 23.13 | 64 |
| Oct. 9, 1942 | 32.95 | 23.25 | 65 |
| Oct. 31, 1941 | 36.30 | 23.03 | 68 |

* New high for year.




*Note: Since Oct. 9, 1942 and up to Oct 30, 1942, even greater relative gains have been made by the air transport group*

# CIVIL AIR PATROL COMPLETES YEAR OF SERVICE

**Volunteer "Flying Minute Men" aid Army and Navy on coastal submarine patrol; civilian organization expanding courier service with private planes.**

By MAJ. EARLE L. JOHNSON, *National Commander*

ONLY A YEAR AGO, Civil Air Patrol came into being through the desire of the civil airmen of the country, as the first orders read, to be utilized with their equipment in the war effort. From its formation a week before Pearl Harbor and from the first meeting of its 48 Wing Commanders, ready to drop what they were doing and pitch in to get this movement rolling, America's fleet of puddlejumper planes has had a wide variety of work to do on a continually increasing scale.

Today, the Wings of Civil Air Patrol in every state, almost without exception, are better organized and more active than at any time since the beginning. Under the Wing Commands, more than 65,000 civilian volunteers have enrolled in the Squadrons and Flights at more than 1,000 airports in all parts of the country.

The first period of CAP development was one of organization and training to band together the private pilots, who flew before as individuals, into hard-hitting units, ready for any type of mission which light planes are capable of flying. The second step was to set up a series of CAP Coastal Patrols; to man and equip them on a volunteer basis, on constant watch for enemy submarines along our shores. The third phase, now well advanced, is to develop inland missions so that qualified flyers in every area may be able to spend as much time as they can devote to the

*On its first birthday the Civil Air Patrol boasts more than 65,000 members organized into Squadrons and Flights at more than 1,000 airports throughout the country. Military drill is a fundamental part of all its training as is shown by these typical Squadrons. Here, part of the personnel and equipment of the Norwood, Mass., Squadron and below, a unit at Lambert St. Louis Field stand inspection.*

Patrol on useful wartime missions.

At the beginning, each local unit stood as an aerial home guard, drilling and practicing for the attack all hoped would never come. Most of the State Guard aviation units were disbanded and merged with the Patrol because of the greater flexibility of the national organization in performing missions regardless of state lines. Close cooperation had been maintained with the ground services in the states and with the protective units of the Office of Civilian Defense, of which CAP is a division.

But the Patrol soon had the good fortune to be assigned also to active missions for which men and planes were detached from their local Squadrons for service at CAP coastal bases and courier stations. Thousands of members who were in a position to volunteer 30 days or more continuous service in a year have gone on CAP active duty and many more are waiting their turn. The nation-wide character of the Patrol is indicated by the fact that members from more than 40 states are now on active assignments.

The most spectacular work is on the Coastal Patrol which began to operate early in the year when the Axis was taking heavy toll of American tankers and merchant vessels on the vital supply routes alon our shores. In the words of Major Gen. Follett Bradley, these "Flying Minute Men" brought their own planes, repair tools, radios, and other equipment to fly under military discipline like well-organized football teams. Submarines spotted by CAP have been sunk, Gen. Bradley revealed. Others about to attack vessels have crash dived on the approach of CAP planes. Vessels in distress have been reported and hundreds of survivors of torpedoings have been located for rescue by surface vessels.

This work is done under the command of CAP's own volunteer officers under the general supervision of the Army Air Forces. Most of the men are ineligible for military service. Many

*Coastal patrol, in which CAP's members free Army and Navy pilots and planes for other work, is one of the most important of the year-old civilian organization's duties. Many of the volunteers serving as pilots, observers or ground crewmen have completely given up their peacetime lines of business to go on active duty "for the duration." Here is an operations office at a base "somewhere on the East Coast" where both men and women members from the Maine Wing take their tours of duty.*

*ABOVE: Civil Air Patrol pilots have aided both civilian defense groups and the armed forces in many ways. Air raid warning systems, blackout regulations, and simulated bombings have helped train civilian defense workers, while Army Air Forces have used CAP pilots and planes for courier service.*

*LEFT: Some ingenious devices have been born of necessity and built by CAP members. There is, for example, the office and radio control trailer built by the Michigan Wing which recently dedicated its own airport, "Wings Field," built by CAP members themselves.*

were flyers in the last war, too old now to be fighter pilots on hot ships but still keen eyed and steady at the controls, proud to be able to help the work of the Army by flying in their country's service. They are proud of the bases they have developed through their own labor and ingenuity, working just for expense money with a moderate per diem to cover their living and equipment costs and a moderate hourly rental for their planes when in the air. That is the way they want it. It is the volunteer spirit which has made the whole enterprise carry on with the enthusiasm and economy that it has.

Men from all walks of life and of all ages from teen-age youngsters to grandfathers are living and working and flying together with perfect teamwork. Time and again, a member who thought he was coming for only a few weeks has gone back home only to wind up his business and return for the duration, unwilling to miss a day in the biggest game hunt that civilians are privileged to join.

Courier service for the Army—the flying of officers, dispatches, and rush shipments between military posts—is beginning to approach the Coastal Patrol in magnitude and is likely to surpass it. While planes with upwards of 90 hp. are needed on the coast, the lighter aircraft—of which there are still many thousands in airworthy condition—are flying the inland missions.

In the Pacific Northwest, thousands of miles per day are being flown on regular routes and schedules. Similar service is developing over wide areas. Courier stations have been set up also for war industries, especially in Pennsylvania and other Eastern states, and are spreading into other areas. Just a few days ago, an entire production line was tied up for lack of 16 lb. of special parts. A CAP plane brought the shipment in a few hours and production was resumed. This sort of thing has happened again and again, on top of the every-day routine work.

Other active missions include aerial target towing, reconnaissance and inspection flights, searchlight and gunnery tracking, and mock strafing of ground troops in training. Forest patrol missions have been flown in many states for the U.S. Forest Service, sometimes on instruments over the smoke of big fires. In cooperation with civilian defense, mock air raids, blackout observations, and tests of the aircraft warning system are almost a daily occurrence. Local units put their practice missions into practical use by such work as scouting for junk piles containing precious salvage metal.

To draw crowds for bond rallies and recruitment drives, the little civil airplane can substitute for the bombers which are needed elsewhere. To the people these home-town planes symbolize protecting wings in the sky and, in view of what they are doing on the coast, they are a good deal more than symbolic. In natural disasters such as floods and tornadoes, the local units have turned out for rescue flights, carrying medical supplies, and guard duty demonstrating their alertness for war emergency.

The members not on active duty are simulating actual wartime assignments in their intensive practice program. Although CAP is not a flight training corps, its study courses and practice missions result in the advancement of those who were pilots when the program began and has encouraged many to take lessons and learn to fly. Thousands have gone out of the Patrol into the armed services, the Air Transport Command, the airlines, and the pilot training schools better prepared by reason of their CAP experience.

The basic CAP course begins with 81 hr. of military drill, discipline, and defense subjects. The 150-hr. advanced course goes on to meteorology, air navigation, crash procedure, and detailed flying missions. As the training is now shaping up, each member will be required to take all the ground work necessary for a private pilot's license and a good deal more besides.

The units out in the field are highly versatile in developing new activities far beyond anything that the staff in Washington could think up. We swap these ideas around among the Wings and if one unit develops a plan that is good, the rest quickly follow suit. Each unit has its staff of officers with specialized functions such as operations, medical, intelligence, communications, photographic, and transportation. Thus these outfits are self-contained with the talent and the equipment to carry out all sorts of missions with no outside help. About a third of the members are pilots; a third student pilots; and rest with related skills such as mechanics, radio technicians, photographers, auxiliary workers, and ground crews. About 10 percent of the members are women, equally eligible with the men and doing a grand job.

Paralleling the senior organization, the CAP Cadets have been recently formed for a limited number of students in the last two years of senior high school. It is a father and son affair. Each CAP Squadron may form a counterpart Squadron of CAPC. Each man in CAP may sponsor one young man he thinks is most likely to succeed in aviation and each woman member may sponsor one girl. Thus the Patrol is making a junior copy of itself to run its own affairs under the guidance of seasoned airmen.

In all these ways, the civilian pilots of the country are making themselves more and more useful to the war effort. Thus the home-town interest in aviation is being kept at a high pitch in communities all across the country. Few of us can spend much time thinking about what will happen when the war is over. But when the final audit is made, I am confident that the Patrol will have proven a strong influence in the full-scale development of civilian aviation which will come when we have won peace again.

*Organization of the Civil Air Patrol Cadets is the newest venture of CAP. Minnesota's Wing was first to get under way with the group shown here. Under this new program every CAP member may sponsor one outstanding boy or girl in the last two years of high school for training which will fit them for Patrol membership upon reaching the required age limit.*

*CAP's basic training course embraces 81 hr. of military drill, discipline and defense subjects and its advanced course of 150 hr. embraces navigation, meteorology and detailed flying missions. Many Squadrons, however, add other subjects to their curriculum. Here the Birmingham, Ala., squadron delves into photography to give its members additional knowledge of a vital part in gaining air superiority.*

WINS HER CAPTAIN'S BARS

*Miss Virginia Combs is the only woman member of the Oklahoma CAP Wing to be commissioned as a Captain, serving as adjutant for the Sooner State's Patrol. Her prompt action in ordering CAP planes in the air during last spring's tornadoes was credited with saving many lives.*

## ON PATROL . . .

• CAP courier service continues to expand its scope of usefulness to the nation; latest developments come from the Northwest where regular daily schedules are now being flown for the Army, with some flights extending as far away as Utah and the Dakotas, covering territory where the Patrol has heretofore had little opportunity for active duty except for occasional forest patrol and search missions. . . The Indiana Wing has arranged a contract with the Forest Service for patrol flights and planes with pilots and observers have already taken to the air. . . There's no limit to what CAP is called upon to do; in Utah, for instance, a mission located 600 sheep that had strayed into territory that defied ground-bound searching parties. . . The Gary, Ind., Group located 25 mi. of abandoned railroad track and a deserted junk yard. . . Group 514, Cleveland, is conducting a survey on behalf of the Greater Cleveland Civilian Camouflage Committee to check visibility of landmarks in that area. . . Rosters of CAP active-duty missions now carry names of members from no less than 44 states. . . Maj. B. E. Fulton, AEF, long Akron Airport manager and a CAP Group Commander, has been assigned to duty at National Headquarters.

## ALONG THE APRON . . .

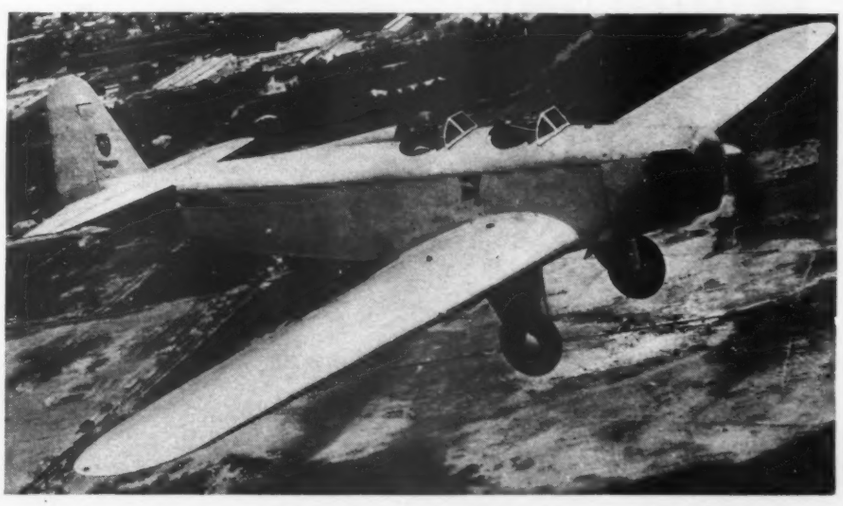
• The Civil Aeronautics Administration has prepared a pilot flow chart—of considerable value to CPT operators—showing the opportunities in the CPT program and the progress of the trainee through the various courses leading to important, well paying flying jobs now open to many who cannot qualify as combat pilots. . . Meteorological training courses at government expense are to be made available to both men and women applicants, the CAA has announced. The courses, leading to positions as junior meteorologists with the U.S. Weather Bureau or Army or Navy commissions, will be given at five leading universities. Applicants must be college graduates or seniors, between 20 and 30 years of age, able to pass the CAA physical examination, have passed one year of differential and integral calculus and one year of college physics. Before appointment can be made, applicants must have acquired a private pilot's certificate of competency. . .The American Aeronautical Institute of Kansas City has opened a Twin-City Division in St. Paul, completely equipped to train aircraft and engine mechanics as well as aircraft welders and sheet metal workers. The new division is under supervision of K. E. Greenwalt, formerly personnel director at the Kansas City school. . . Abrams School of Aerial Photographic Survey and Interpretation has it second class of 44 Marine officers and enlisted men now undergoing an intensive twelve-weeks training period prior to assignment to active duty. . . United Air Lines has completed a revised edition of its teachers' kit, which was prepared by Prof. W. A. Wheatley. It includes a 52-page illustrated manual, photographs and silhouettes. . . Atlantic Aviation Institute, Inc., has purchased the Luscombe School of Aeronautics.

### Univ. of Texas Expands Aeronautical Training

Dr. M. J. Thompson has been appointed chairman of the newly created Department of Aeronautical Engineering as the University of Texas expands an aviation training program started back in 1926.

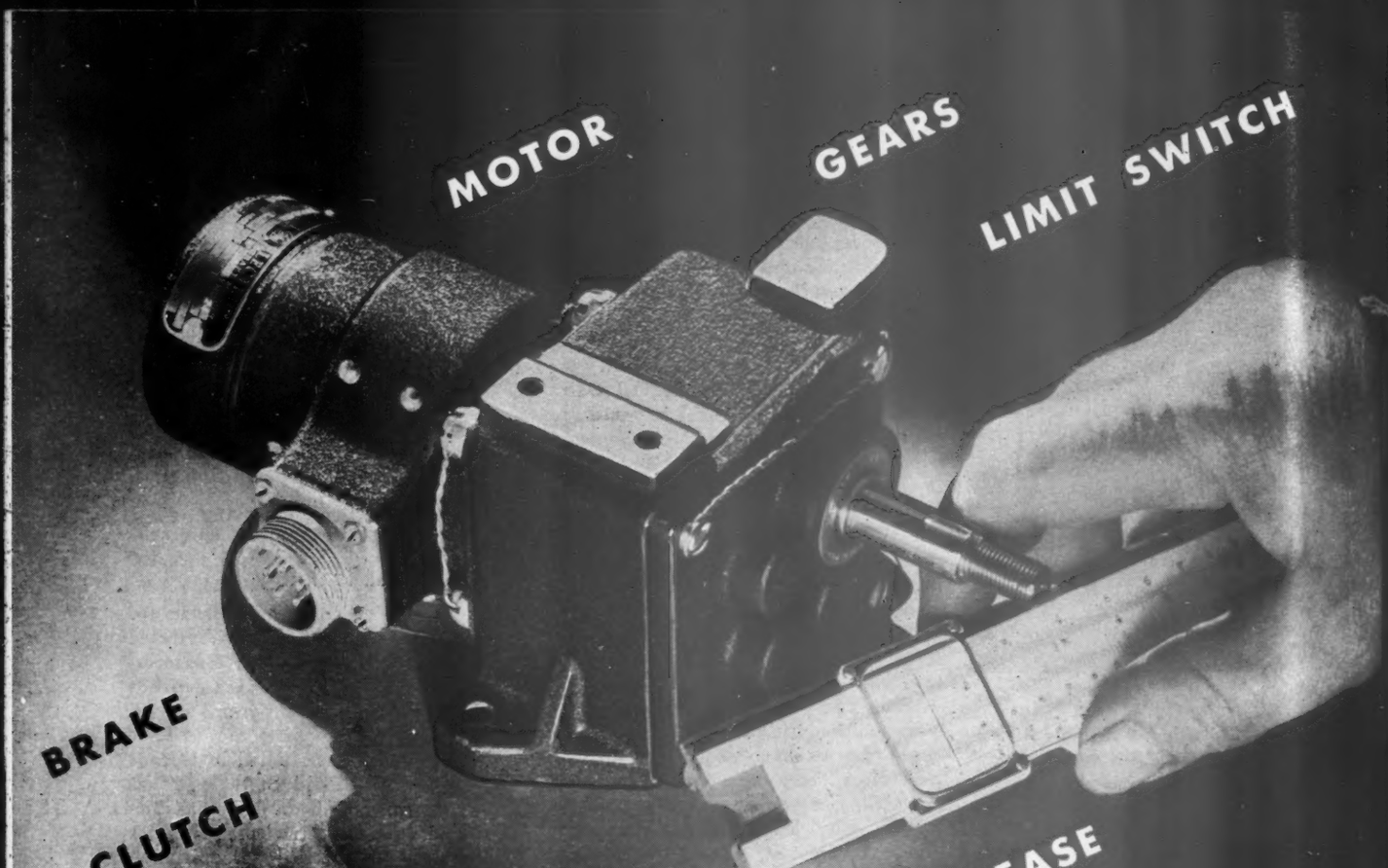
Dr. Thompson has studied in Europe as well as the United States and has served as consultant to numerous aircraft and other industrial organizations on problems in applied aerodynamics. He is assisted by Dr. M. V. Barton, formerly of the University of Maryland and Cornell University, where he developed advanced engineering courses for Bell and Curtiss-Wright engineers.

Other staff members include Harry W. Brown, former holder of a Boeing aeronautical engineering scholarship and a member of the Vega engineering staff, and John C. Bowman, formerly with Consolidated Aircraft Corp.



MEXICAN AIR FORCE TRAINER

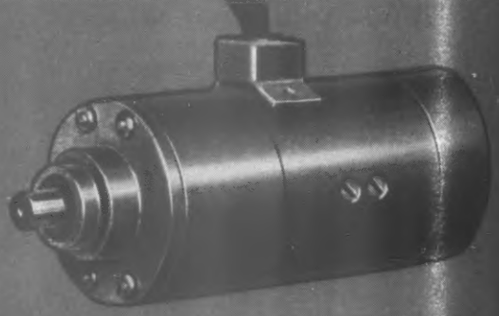
*Reported in large-scale production is the "Tezuitlan" plywood trainer, designed by Antonio Sea and being built under the direction of Gen. Roberto Fierro, Chief of the Mexican Air Force. Powered by a 125-hp. Lycoming engine, the airframe is built almost exclusively of materials native to Mexico. For complete construction and performance details on the "Tezuitlan" see AVIATION, September, 1942, page 227.*




# THE G-E POWER PACKAGE *for Aircraft*

## A Complete Unit... In One Package... Shipped Assembled... Ready to Install

**Wing flap operating power package**—consists of split-compound-wound motor with special clutch.



Power package for operating control and protective devices—consists of motor and gear reduction.

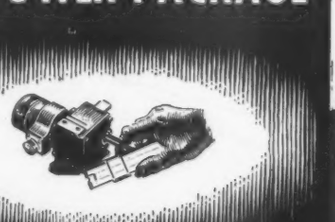
**To simplify plane design and save manufacturing man-hours.** All the required devices to do a complete job are built as one compact, light-weight unit—ready for installation on the plane. The designer who uses a G-E "power package" simplifies his job, and gains time because he is relieved of co-ordinating a complete sub-assembly. He also gains space, because this complete unit is designed compactly to meet limited space requirements. Skilled man-hours on the assembly floor are saved, because the power package eliminates sub-assembly time.

**And "add more lightness."** The G-E power package is lighter than several separate devices that perform the same function. And, being electric, it is operated from an electric power circuit, which is inherently light in weight, and which can be in duplicate for added reliability in combat. This saves over-all weight as compared with other systems offering comparable reliability.

Each power package is fitted to the specific job it is to perform. G-E engineers co-ordinate the motor, gears, control, or other elements required.

When you have a new design under consideration, see the nearest G-E office about obtaining sample power packages for test. Although General Electric factories are now working at full tilt to satisfy the demand for aircraft motors, we will be glad to work with you on the design of equipment for new planes, and to discuss the production requirements such new equipment will involve. *General Electric, Schenectady, N. Y.*

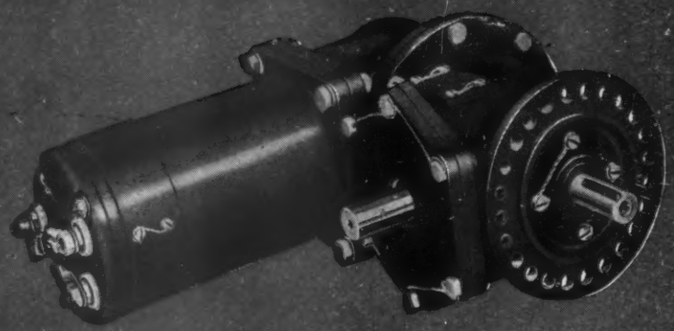
**G-E POWER PACKAGE**



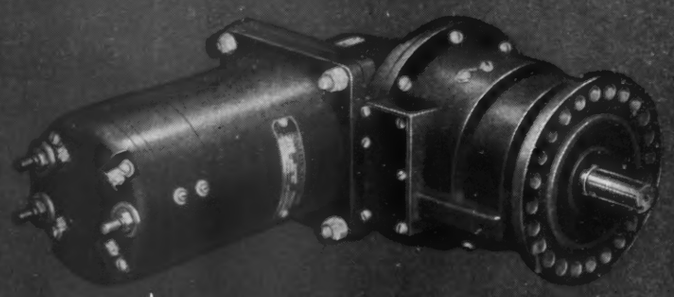
**SEVERAL FUNCTIONS—ONE UNIT**

Including

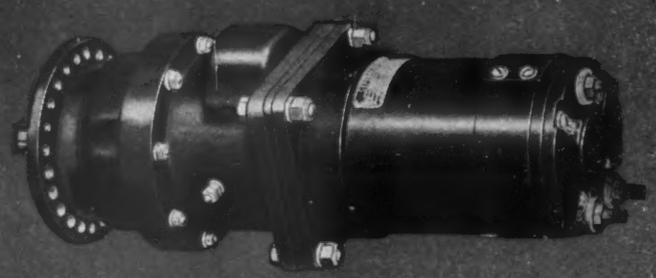
| | | |
|---|---|---|
| Motor | Gears | Limit Switch |
| Brake | Clutch | Load Release |



**Landing-gear operating power package**—consists of motor with built-in magnetic brake, high-efficiency gear reduction, friction clutch on output shaft, and shaft extension for manual operation.

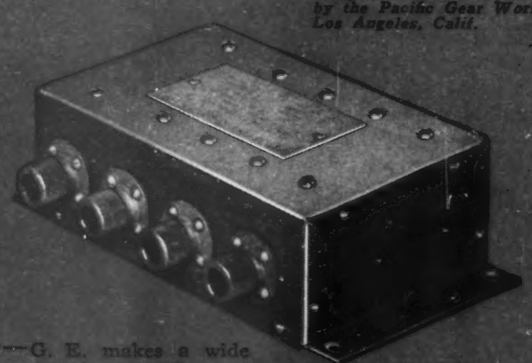


**Bomb-door operating power package**—consists of motor, high-efficiency gear reduction, with a special clutch on output shaft.



**Wing-flap operating power package**—consists of motor, magnetic clutch, high-efficiency gear reduction, and friction clutch.

*Gears for the above units designed and manufactured by the Pacific Gear Works, Los Angeles, Calif.*



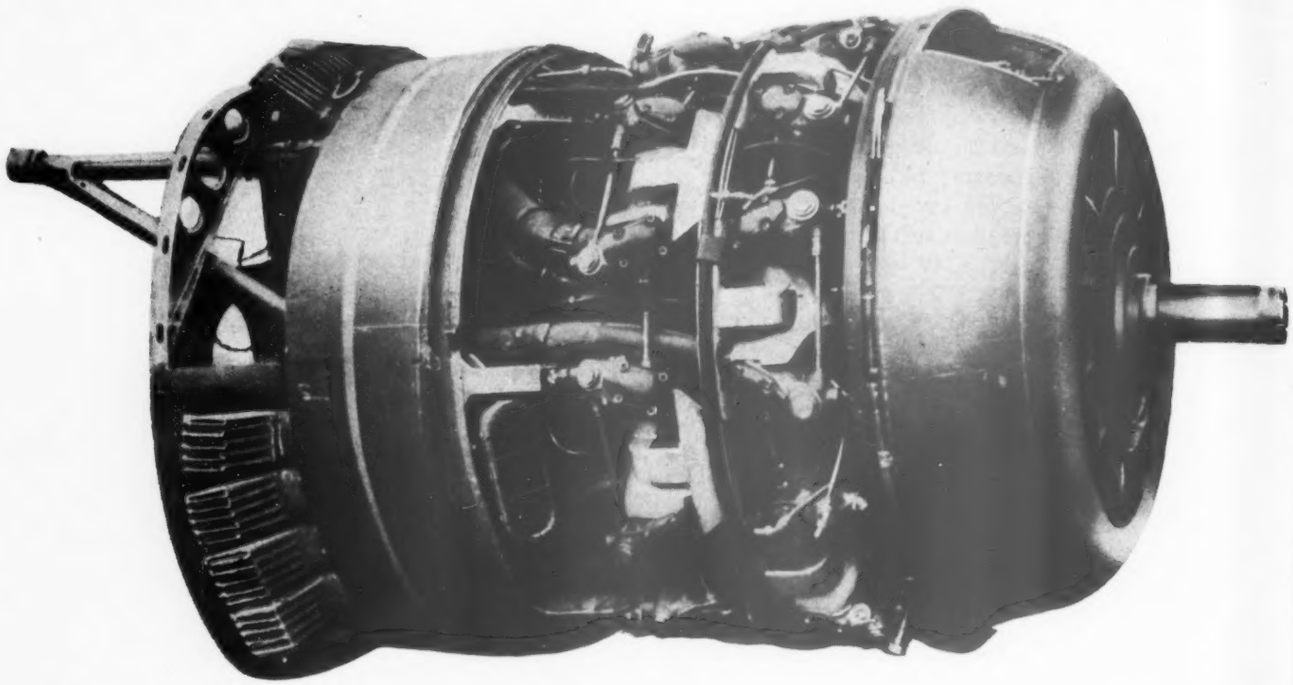
**And remember**—G. E. makes a wide variety of plane equipment. For example, the ballast and transformer (above), for fluorescent lighting of instruments. Will operate four 4-watt lamps, and provides 3-volt, 10-amp power for indicator and rim lights. Weighs only 1.85 lb. In addition, G. E. makes superchargers, turrets, control devices, generators, voltage regulators, reverse-current cutouts, dynamotors, magnetos, instruments, radio equipment, and a variety of wire, conduit, and switches.

**GENERAL ELECTRIC**

200-11-6280

*The BMW-801A, as installed in the Dornier 217E, is a complete and compact power unit—its 1,460 bhp. at 2,400 rpm. at 16,250 ft. making it the highest powered German aircooled motor yet put in large-scale production. The 802—said to develop some 2,000 hp.—has only recently been reported to be coming off assembly lines in sizable quantities. But, while the 801 is a compact unit, it is far from a maintenance man's dream, for accessibility has been sacrificed to a large degree. Apparently the German designers have, instead, figured on speed of replacing the entire engine, for removal of the five engine mount bolts serves to disconnect the whole powerplant except for fuel lines and engine recording instruments.*

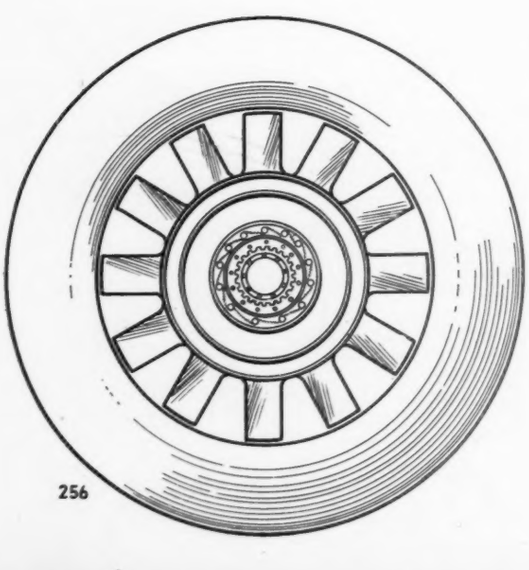
*Illustrations courtesy "Flight"*

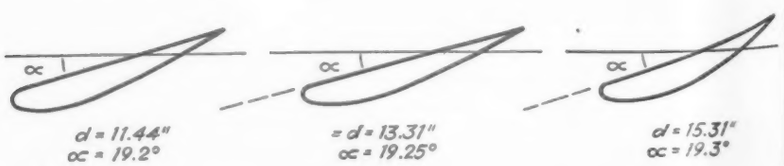


# Design Details of the BMW—801A Engine

**Second part of a first-hand study by an "Aviation" correspondent, showing additional construction features of a leading German aircooled powerplant.**

By MYLES V. CAVE, *"Aviation's" British Correspondent*






*d = 11.44"*
*∝ = 19.2°*

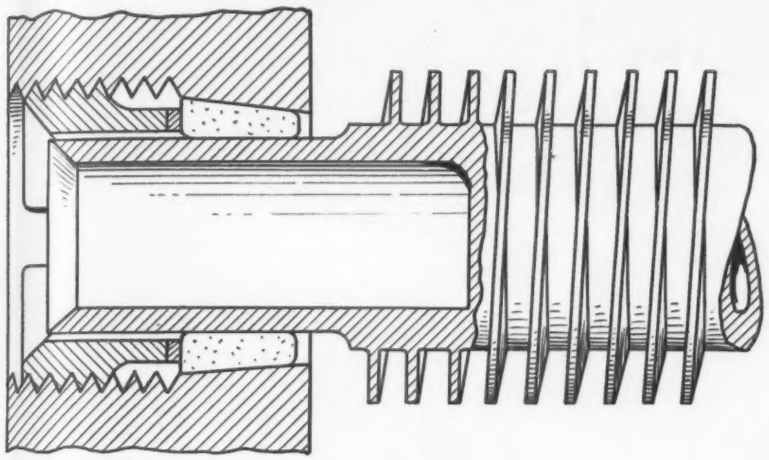
*= d = 13.31"*
*∝ = 19.25°*

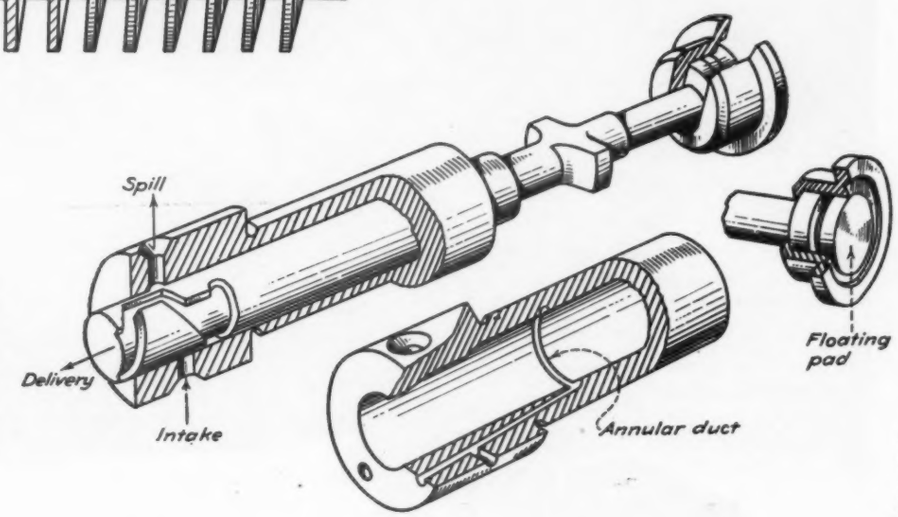
*d = 15.31"*
*∝ = 19.3°*

*d = Distance of section from center. ∝ = Angle of blade*

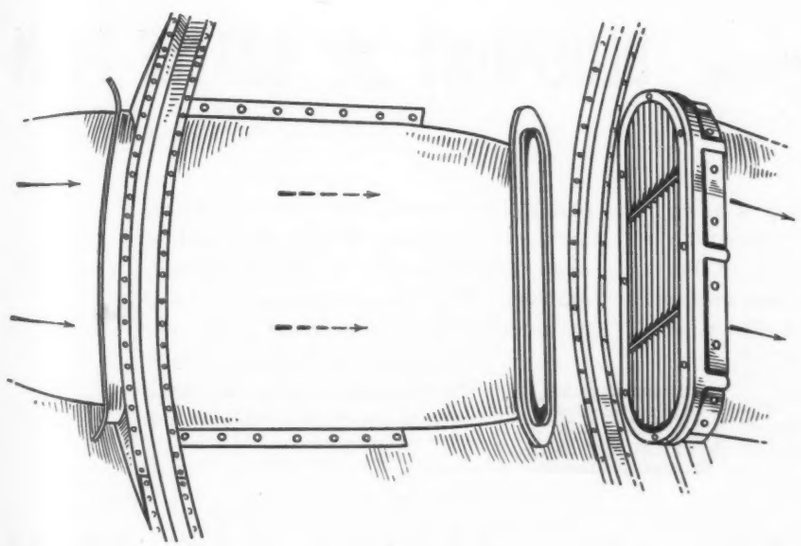
*The extremely close-fitting cowling and the fact that supercharger intakes are located within the cowling have necessitated installation of a cooling fan turning at 1.72 x crankshaft speed located just behind the 13-ft. three-bladed propeller which turns at 0.54 x crankshaft speed. From the fan drive gears is taken the drive for the twin-Bosch ZM 14 magnetos, both of which are mounted vertically on the aluminum alloy front case.*

Oil radiator tubes are sealed by the simple process shown here. The threaded end-fitting screws down onto a taper sleever to make a leakproof joint by pinching the tube.






The fuel injection pump for the BMW-801 is the first multiplunger high pressure pump built for production in radial form and, in many respects, the injection system is similar in design to the familiar Bosch Diesel pump. Each plunger head is helically cut and grooved to provide a suitable angle face to the intake and cutoff ports in the sleeve to allow for varying throttle conditions.



This detail sketch shows one of the supercharger air intakes, set within the cowling. In the photograph opposite the right hand intake can be seen directly behind the mid-lower cylinder and just in front of the rear portion of the cowling. A similar intake is set in a corresponding position on the opposite side. The supercharger operates at 5.05 x crankshaft speed in low gear and 7.46 x crankshaft speed in high gear.

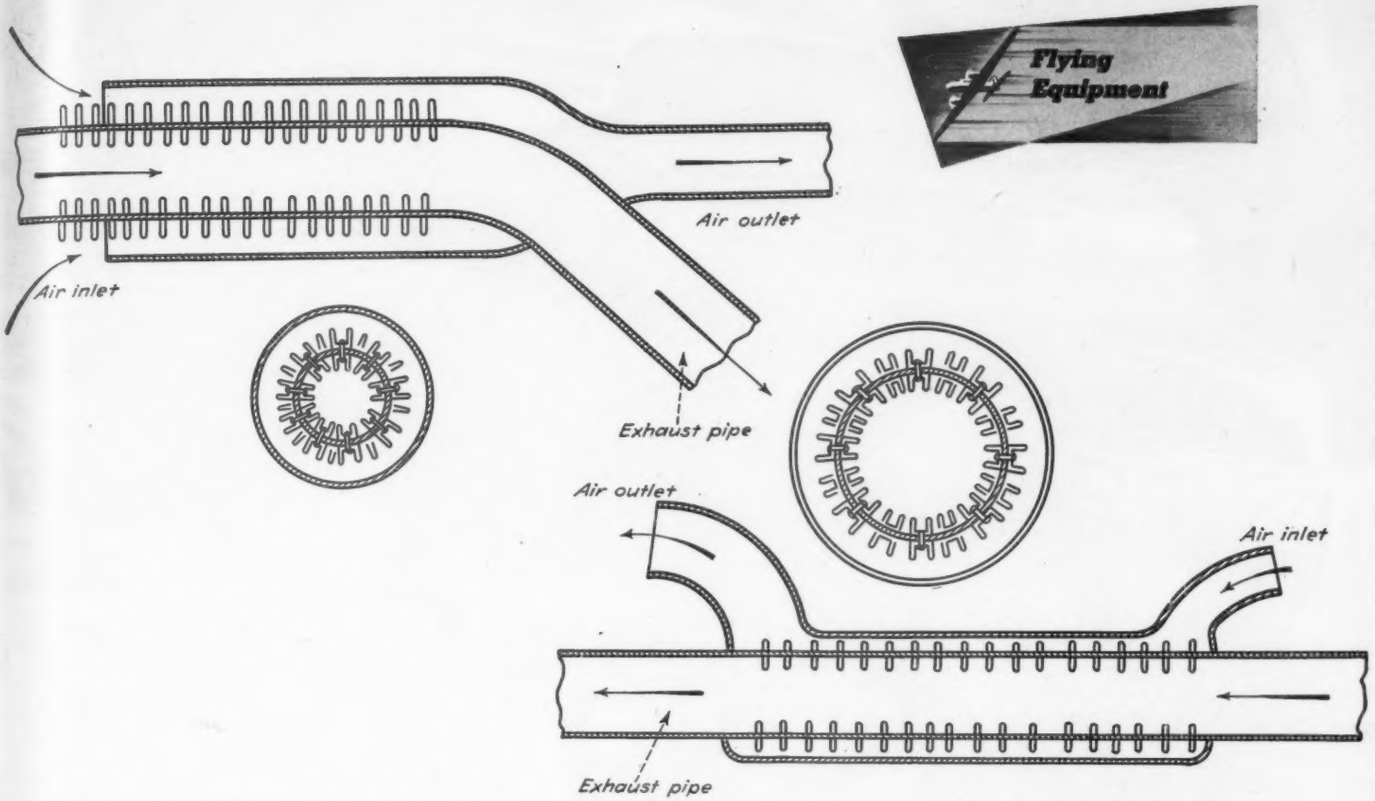
(Continued on page 259)

# *from* BLUEPRINT *to* BATTLE PLAN

BREEZE Radio Ignition Shielding is being produced today in ever-increasing quantities for the fighting forces of the United Nations on land, on the sea, and in the air. Designed for use on hundreds of different types of engines, this shielding has been developed and perfected by Breeze over a period of many years. Through its wide background of experience, Breeze has acquired unequalled know-how in solving shielding problems. From blueprint stages to actual performance on the world's battlefronts, this Radio Ignition Shielding reflects the high quality of Breeze standards in design and manufacture.

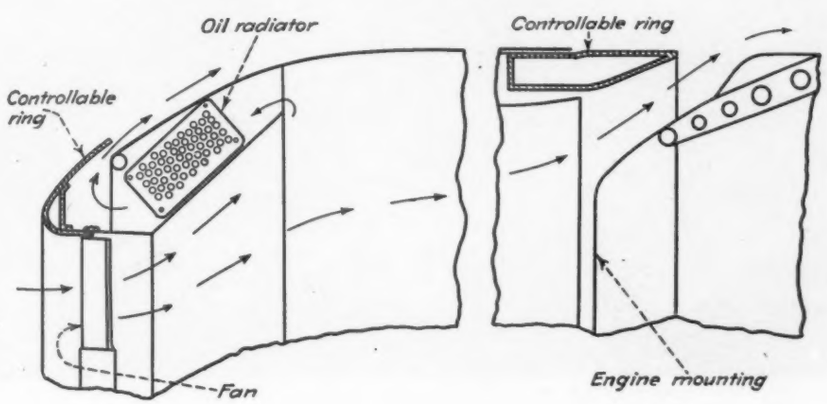
BREEZE MARK

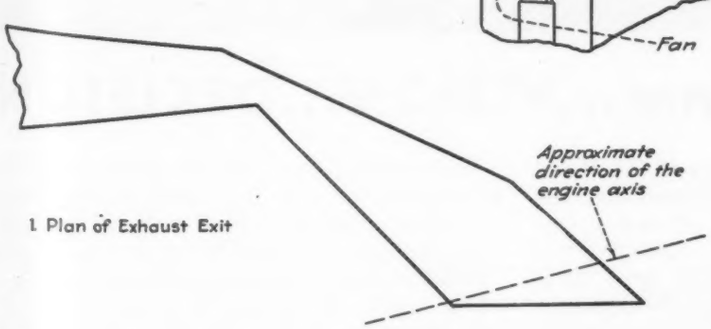
BREEZE CORPORATIONS, INC. · NEWARK, NEW JERSEY



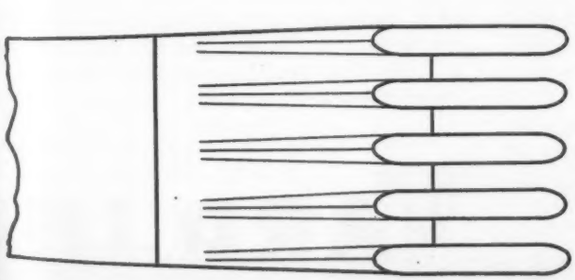

*Both wing de-icing and cabin heating are taken care of through utilization of exhaust heat by a system found on American aircraft at least 15 years ago. At top is shown the arrangement for taking heat off for de-icing of wings and bombardier's compartment; Above is the exhaust jacket for heating the main cabin of the DO-217E. (Also see AVIATION, November, 1942, page 228.)*

*The engine cowling has two pilot-controlled rings for cooling adjustments, one located in the nose and one behind the rear cylinders. The oil radiator is located just behind the nose ring, the cooling air being forced in by the fan and its flow reversed to go through the radiator and out around the cowling. In the Focke-Wulf 190 fighter plane installation, the rear controllable ring is eliminated.*




1. Plan of Exhaust Exit



2. Elevation of Exhaust Exit

*Exhaust flame damping is accomplished with what appear to be exceptionally short stacks which, as may be seen in the photo on page 256, are grouped at the top of the engine and below the middle on each side. In reality, however, the exhaust pipes have considerable length, since they are inside the cowling well back of the engine the only exposed part being the flame damping exits.*

# Reconnaissance...VISION...DECISION

When sniper's bullets whip past your head — when you have to send your precious few tanks and men into the teeth of enemy machine gun and artillery fire — that's when good vision counts! When every decision is influenced by *what you see*—your field glasses become an important instrument of warfare.

Military field glasses need more than the ordinary measure of precision in magnification and field of view. Their value is only as great as their light gathering power.

VARD is making lenses, prisms and reticles for our Army and Navy. With skill born of tradition in making precision equipment, VARD technicians work on these optical parts knowing that only *perfection* is *good enough*.

Other VARD divisions produce navigation instruments, aircraft hydraulic parts and actuating units, precision testing equipment and precision tools for machined parts. The hope and earnest effort of VARD management and men together is to give our soldiers, sailors, marines and airmen the tools which can win —tools that are the *best* that can be built— Anywhere.

**VARD INC.**

PASADENA, CALIFORNIA

*The Stinson L-5 "Reliant" has been designed to serve as the eyes of the ground troops, and built to accompany infantry, artillery, cavalry or tank corps wherever they may go into action. Packed with radio equipment, the pilot and observer can maintain communication not only with all types of ground troops, but with other aircraft as well.*

*The L-5's 190-hp. Lycoming engine lifts the plane almost vertically after a very short run, a vital feature since the plane must be able to operate from extremely restricted areas in rough terrain. Both slots and flaps are provided to shorten takeoff and landing runs and to give stability for slow observation flying. Said to have an unusually high top speed for planes of this type, the L-5 can be kept in the air at less than 45 mph. for directing troop movements or artillery fire below.*

# TWO NEW STINSON WARPLANES

**L-5 Army liaison plane with wide performance range and AT-19, wartime version of "Reliant," for British navigation training.**

DETAILS of two new planes, the L-5 and the AT-19, which have been put in production by the Stinson Division of Vultee Aircraft, Inc., have just been released by the Army Air Forces.

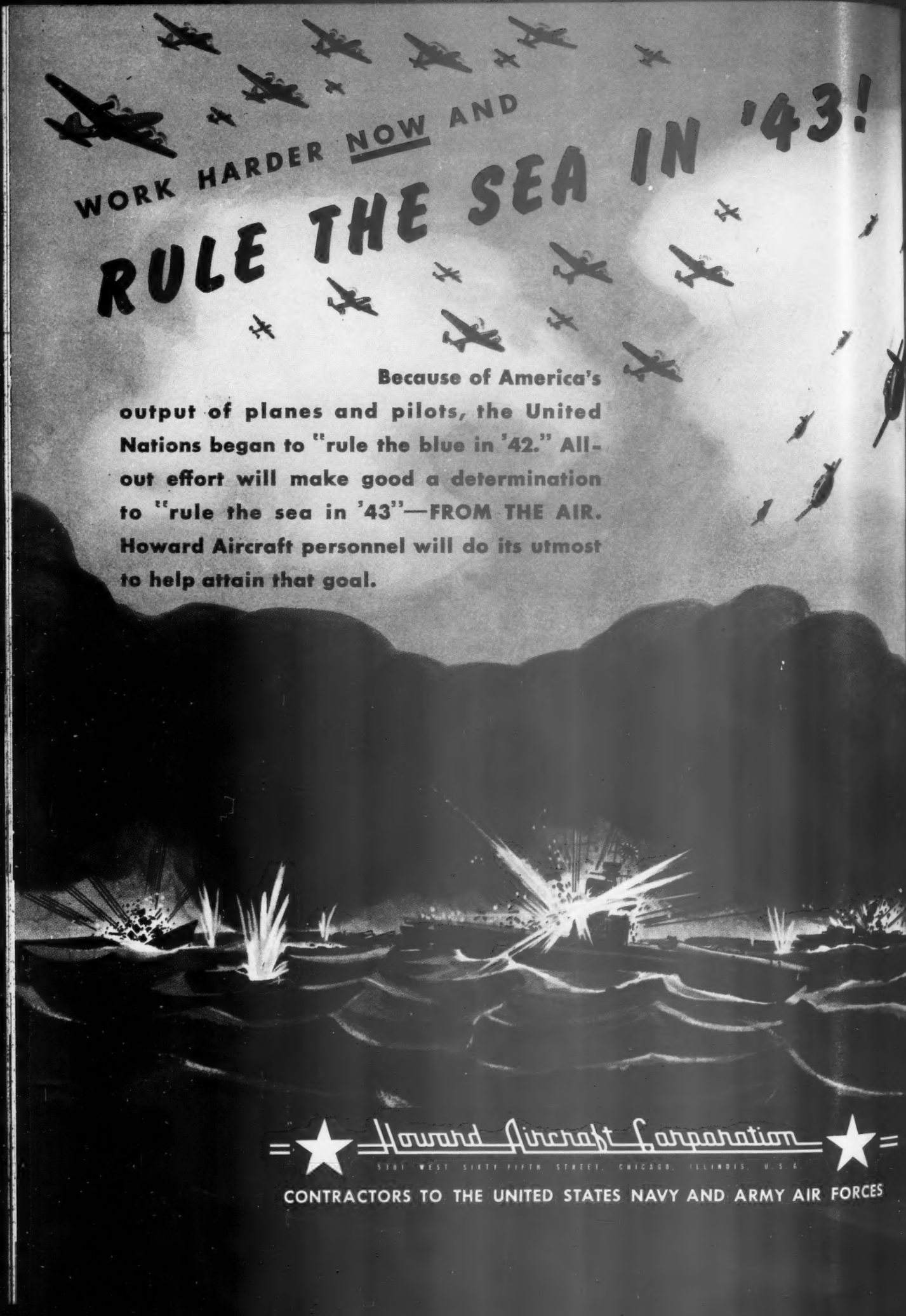
The L-5 *Sentinel* liaison plane is a two-place high wing monoplane which uses 20 percent less steel and 70 percent less aluminum than were called for in original designs. The fuselage is of welded steel tubing, fabric covered, and the wings and tail surfaces are of wood. Designed to operate wherever ground troops are in action, the L-5 has a very short takeoff run and high rate of climb. Since liaison planes must often land on ordinary roads or rough fields, the spring-and-oil shock absorbers have nearly twice the length of stroke of conventional types.

Equipped with both slots and landing flaps, the L-5 is said to have an unusually wide range of speed. For artillery fire-spotting it can be kept in flight at less than 45 mph. Equipment for pilot and observer includes radio units for communication with all types of ground troops as well as other aircraft.

Wing span is 34 ft., length, 24 ft., and weight is 2,100 lb. The L-5 is powered by a 190-hp. horizontally opposed aircooled Lycoming engine.

The AT-19 *Reliant* is being built under AAF direction for assignment to the British as a navigation trainer for British naval flyers. A high, gull-winged craft, the AT-19 is essentially the peacetime *Reliant* but to what extent it has been redesigned, other than the fact that the fuselage has been lengthened, has not been revealed.

*The Stinson AT-19 is a wartime version of the well known "Reliant" which is being built under Army Air Forces direction for assignment to England as a navigation trainer for British naval flyers. Extent of the redesigning, other than the fact that the fuselage has been lengthened, has not been released by the AAF.*


WORK HARDER NOW AND
RULE THE SEA IN '43!
Because of America's output of planes and pilots, the United Nations began to "rule the blue in '42." All-out effort will make good a determination to "rule the sea in '43"—FROM THE AIR. Howard Aircraft personnel will do its utmost to help attain that goal.
Howard Aircraft Corporation
5301 WEST SIXTY FIFTH STREET, CHICAGO, ILLINOIS, U.S.A.
CONTRACTORS TO THE UNITED STATES NAVY AND ARMY AIR FORCES

Flying Equipment

*Completely equipped to train multi-engine bomber crews as a complete team, the Boeing AT-15 is in reality a small bomber, for it is completely equipped, even to bomb racks. Its two Pratt & Whitney engines give the craft a speed in excess of 200 mph.*

*The AT-15 crew trainer is so arranged that individual as well as group instruction can be given the advanced students who are in the final stages of their training. Note the navigator's hatch and power-operated gun turret.*

# BOEING AT-15 Bomber Crew Trainer

**Twin engine advanced trainer develops teamwork of pilot, navigators, bombardiers, gunners and cameramen.**

THE BOEING AT-15 advanced crew trainer has been designed to train bomber crews as an integral unit, giving the pilots, co-pilots, bombardiers, navigators and gun crews the coordination and teamwork which is essential to successful operation of the multi-engine bombers with which the Army Air Forces are piling up their amazing combat record. The craft is so arranged that individual as well as group instruction may be given.

Elimination of the use of strategic materials such as aluminum castings and alloys was a prime consideration in the design of the plane. The fuselage is of welded steel tubing construction, wood-faired and fabric covered, while wings and tail surfaces are plywood covered. The AT-15 has a wing span of 59 ft. 9 in. and a length of 42 ft. 2 in. Powered by two Pratt & Whitney engines, spinning Hamilton Standard constant speed propellers, it has a speed that is in excess of 200 mph.

Equipment includes radio compass, automatic pilot, full complement of flight and radio equipment, flexible machine gun, flexible camera gun, power turret and bomb bays.

### Troop Glider Revealed

Also in large-scale production is the CG-4, 15-man troop glider designed for service wherever American airborne troops may be called into action. The CG-4 is built almost entirely of non-strategic materials and was designed for typical American mass production methods.

*Also coming off the Boeing production lines are large numbers of the CG-4 troop carrying glider with a capacity of 15 fully equipped airborne soldiers. The CG-4 is constructed almost entirely of non-critical materials.*

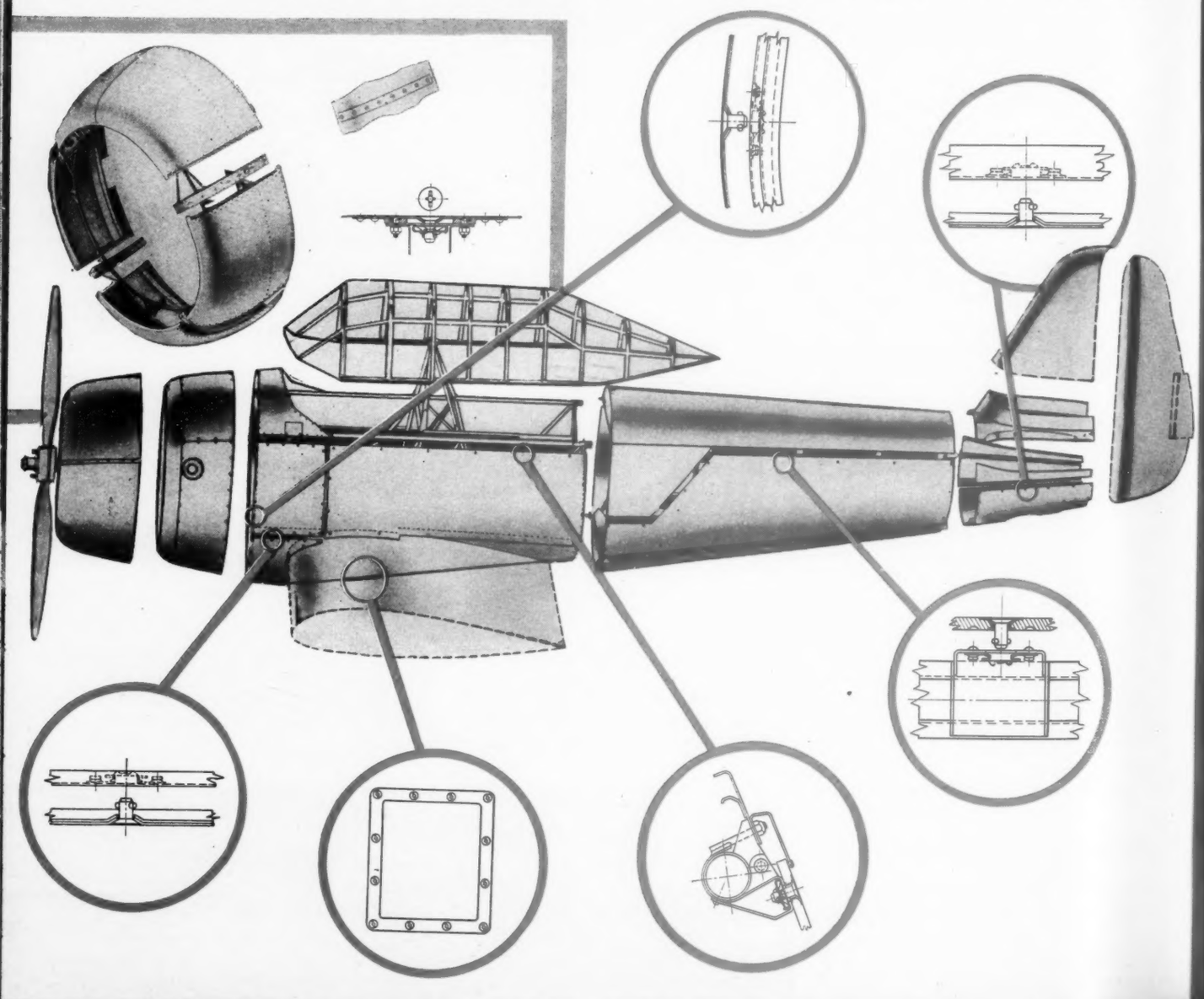
SPECIFY

# SHAKEPROOF COWL FASTENERS

for

## Metal and Plywood Applications

Here's how *FLEETWINGS* uses them on its BT-12



BE SURE TO SEND FOR SHAKEPROOF COWL

# Here's Why!

- A standard Shakeproof Cowl Fastener Assembly consists of only three parts—spring unit, stud and cross pin—is compact in size and light in weight.
- Shop assembly operations are reduced to utmost simplicity, requiring only standard drilling and dimpling procedures, and insertion of the cross pin in the stud with special pliers.
- Ground crew replacement is correspondingly practical and special adapters are available to permit installation where parts have been tooled for grommet type fastener.
- Shakeproof Cowl Fasteners also have the advantage of actually reinforcing rather than weakening the adjacent structural area—eliminating any possibility of distortion in aluminum sheets.
- The reinforcing base also eliminates load concentration and thus removes the danger of stress hazards, particularly shear at the aluminum attaching rivets.
- Through equalized springing the deflection of the spring unit is definitely limited. The base is formed to provide continuous positive support when the upper flexing bridge reaches the pre-determined limiting point.
- When the Shakeproof Cowl Fastener is turned to the locked position, a pair of abutments or stops prevent further turning of the stud. The assembler thus has assurance that the fastener is locked tight.
- Cover plate, cowling, or other curved or faired sheets attached with Shakeproof Cowl Fasteners may be readily removed without binding on the part of the individual studs—a definite advantage over grommet type studs.
- The design of the fastener assures quick alignment of the sheets to be fastened, compensates for variation in sheet thicknesses and provides for addition of accessories such as stud ejector springs and right angle mounting brackets.

## AVIATION ENGINEERS

### Send for detailed engineering and procurement data book!

Catalog AD-2 is a comprehensive presentation of Shakeproof Cowl Fasteners. It thoroughly explains the advantages of this better fastener and gives complete engineering, procurement and test data. Write for your copy today!

★ ★ ★

Testing samples are also available to aircraft engineers, buyers and production men!

## SHAKEPROOF inc.

"FASTENING HEADQUARTERS"

**2501 North Keeler Avenue, Chicago, Illinois**

Distributor of Shakeproof Products Manufactured by
ILLINOIS TOOL WORKS

In Canada: Canada Illinois Tools, Ltd., Toronto, Ontario

SEMS FASTENER UNITS • THREAD-CUTTING SCREWS • LOCK WASHERS • COWL FASTENERS • LOCKING AND PLAIN TERMINALS • LOCKING SCREWS • RADIO AND INSTRUMENT GEARS • SPECIAL STAMPINGS

FASTENER CATALOG!

# BE READY FOR WINTER'S ATTACK

INSPECT AND EQUIP YOUR FWD's NOW . . . FOR FAST LOW-COST AIRPORT SNOW CLEARING

Hundreds of FWD's, similar to this model, will soon be put in harness for the winter's work—fitted with mounting equipment and snowplows ready to get into action fighting snow, after a busy spring and summer on regular airport maintenance work.

FWD

# KEEPING 'EM IN THE BLUE . . . . Calls For Good Clear Runways Below . . . .

Keep 'em flying by giving 'em runways clear and clean of snow. At airports in every state in the snow belt and many Canadian provinces (where heavy snowfalls are a constant menace) FWD trucks are being made ready for snow clearing duty — a service in which they have earned and kept first place.

In cooperation with the aims of the U. S. Truck Conservation Program, FWD lists here a few practical suggestions to enable airport operators to get the most in performance with minimum maintenance out of their FWD snow removal trucks:

**Conserve tires**—snow removal truck operators are universally agreed that single tires are best in snow removal service. The use of single tires of the same size on all four wheels not only conserves rubber but also reduces excessive differential action, thus prolonging the life of the truck. Closely spaced tire chains—not emergency chains—should be used on all four wheels, for maximum traction and least slippage and damage to tires.

**Care of engine**—change engine oil frequently enough based on total hours of operation. Keep cooling system clean and free of rust. Control engine temperature with a radiator hood or automatic shutter.

**Storing the truck** — sub-zero temperatures make lubricants too stiff and solid, cause steels to become brittle. House all your trucks when not in use — avoid outdoor storage for longer truck life.

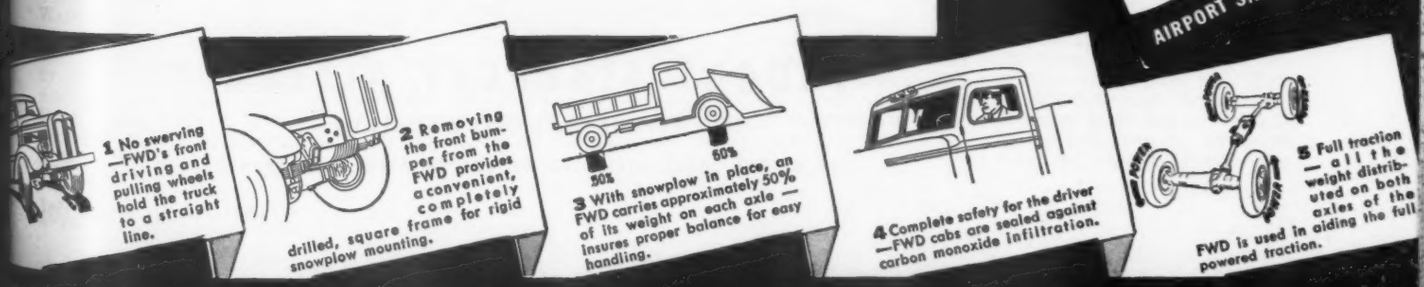
**Inspect your trucks**—periodically and check for needed replacements —take advantage of FWD's principle of progressive interchangeability of improvements and vital parts.

## See Your FWD Branch or Dealer

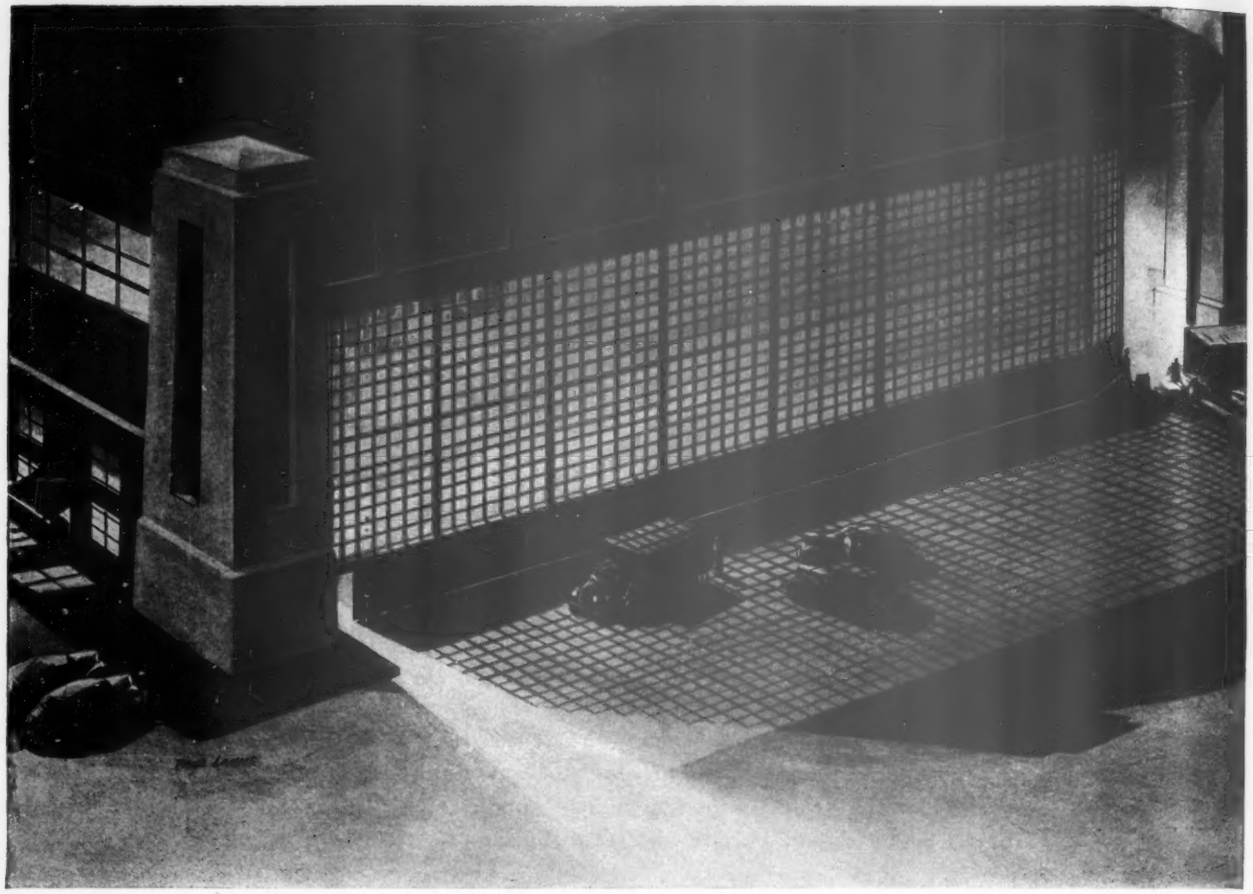
The entire FWD organization of factory branches, FWD dealers, and district servicemen are all pledged to help you get the most out of your trucks by aiding your program of preventive maintenance. Call on them frequently for sound maintenance advice and skilled service.

**THE FOUR WHEEL DRIVE AUTO COMPANY**
CLINTONVILLE, WISCONSIN • *Canadian Factory: Kitchener, Ont.*

FWD
TRUCKS
—THE PREFERRED TRUCK
FOR FAST, LOW-COST
AIRPORT SNOW CLEARING


1 No swerving—FWD's front driving and pulling wheels hold the truck to a straight line.
2 Removing the front bumper from the FWD provides a convenient, completely drilled, square frame for rigid snowplow mounting.
50%
50%
3 With snowplow in place, an FWD carries approximately 50% of its weight on each axle — insures proper balance for easy handling.
4 Complete safety for the driver —FWD cabs are sealed against carbon monoxide infiltration.
5 Full traction — all the weight distributed on both axles of the FWD is used in aiding the full powered traction.

THE FWD FOUR-WHEEL-DRIVE TRUCK PROVIDES SO MANY OUTSTANDING SNOW REMOVAL ADVANTAGES



# *Inside Secret Hangars*

When war came to the United States, the aircraft industry was prepared for action. Ready with superior equipment fully developed, the industry expanded quickly into quantity production, enlisting at the same time the productive capacity of other industries.

Behind this achievement lie years of perseverance and millions of brain-hours in research, engineering and development.

In this exacting work Vought-Sikorsky has long played a pioneering role. For 25 years its designers and engineers have periodically come forward with planes of advanced design that have led to outstanding achievements in military and commercial operations. Now, inside secret hangars, new types are taking shape that will help carry American air superiority to new heights.

**VOUGHT-SIKORSKY AIRCRAFT**

**Stratford, Connecticut**

ONE OF THE THREE DIVISIONS OF UNITED AIRCRAFT CORPORATION

# The AVIATION NEWS

BLAINE STUBBLEFIELD, Washington C. B. F. MACAULEY, New York E. EUGENE MILLER, New York JOHN FOSTER, JR., New York

## See New Controlled Materials Plan As "Principal Framework" for WPB

Washington (AVIATION Bureau)—The Controlled Materials Plan, scheduled to replace the Production Requirements Plan, may eventually become the "principal framework" of WPB operation, it was predicted here as details of the plan became known.

Chairman of the Controlled Materials Board is Harold Boechenstein, president and general manager, Owens-Corning Fiberglas Corp., and assistant director is W. C. Skuce, supervisor of materials procurement, General Electric Co.

In broad outline, CMP is designed as a yardstick for purchase of all materials—a means of eliminating overbuying and a plan to match available materials with authorized and scheduled production. In operation, its Requirements Committee will, by Feb. 1, make tonnage allotments for the second quarter of 1943 to the seven so-called claimant agencies: The War and Navy Departments; Aircraft Scheduling Unit; Maritime Commission; Lend-Lease; Office of Civilian Supply; and Board of Economic Warfare.

These agencies will, in turn, divide their allotments among the prime contractors involved, who will further divide the allotments among their subcontractors.

Aluminum, steel, and copper are the first materials to be listed, but others will be added soon. After July 1, 1943, when CMP is expected to be in full operation, mills producing these metals must fill orders through allotments under the plan. For three months prior to that date, preference ratings will take care of manufacturers who do not receive their CMP allotments in time. However, it should be noted that allotments for a given month will be filled ahead of orders bearing preference ratings. Distribution of all materials other than CMP-regulated materials will be governed by preference ratings.

Revisions of material flow to take care of design changes must be taken care of by the claimant agency, WPB officials have declared, pointing out that if such changes involve additional material, the agency may appeal for it.

## Cripps Heads British Aircraft Production

In an unexpected cabinet shakeup, Sir Stafford Cripps has become Britain's Minister of Aircraft Production. He succeeds Col. J. J. Llewellin, who moves to the newly created post of Resident Minister at Washington, D. C., where he is slated to assume charge of supplies.

In taking the new post, Sir Stafford has resigned from the War Cabinet in what some of his friends have considered "a political move to keep him from the spotlight." However, Prime Minister Churchill, in asking him to accept the post, wrote: "It seems to me that the production of aircraft and the development of radio technique lie at the very heart of our affairs."

## Combat Needs Void N-K Cargo Plane Order

Cancellation of the Navy's contract with the Nash-Kelvinator Corp. for cargo flying boats is announced by Rear Adm. E. M. Pace, Jr., director of the Navy Department's materials division. Reason: Pressing need for more combat planes and patrol bombers in the South Pacific war theater.

"Above all we must give the men on the firing line the planes and weapons they require," states Adm. Pace, "and that now means that some of the facilities available through Nash-Kelvinator for flying boat production will have to be turned over to contractors who are already at work on the types of planes we now need."

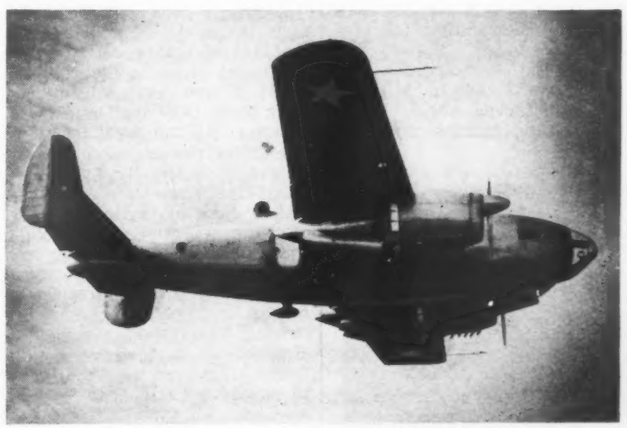
Accordingly, George Mason, Nash-Kelvinator president, reports that his corporation's new plant in the South will be taken by another manufacturer. Meanwhile, some of the subassembly facilities laid out for production of the cargo planes (they were to be Vought-Sikorsky types) will be converted to the making of combat-plane engines and propellers. This will simply increase Nash-Kelvinator's present schedules on these products, and thus dislocation of labor in the affected plants will be avoided.

## TWA & UAL Capital Flights

CAB examiners have urged grant of temporary airline certificates to TWA and United Air Lines to operate services into Washington, D. C. TWA would fly from Dayton, Ohio, while United would come in from Toledo. The lines say they do not need any new equipment for the proposed service. Early decision by the board is expected, after which final permission must come from the War Department. It is believed approval will be granted in line with promoting prosecution of the war.

## Walsh, Miller Promoted

Advancement of Raycroft Walsh from the post of vice-president to that of senior vice-president is announced by the United Aircraft Corp. And new vice-president is J. Reed Miller, formerly general manager of the corporation's export division.



SLEEK SUCCESSOR TO AT-13

Tested—Fairchild's new AT-14 bomber-crew trainer. Seen here in first flight over company's Maryland field, AT-14 is built almost entirely of plastic-bonded plywood via Duramold process. Two Ranger in-line aircooled twelve-cylinder engines, each supplying 520 hp. for takeoff and 450 hp. at 12,000 ft., power this 200-mph.-class craft. Both tactical equipment and ample space is provided to train bomber crews "to coordinate as a team," states Vice-President R. S. Boutelle, who further points out that plane embodies many advances in design over original AT-13 trainer (detailed on p. 225, September, 1942, "Aviation"). Approximately 53 ft. in. wing span and 38 ft. in over-all length, AT-14 carries ten 100-lb. bombs, recent-type bombsight, and machine gun (interchangeable with gun camera) in power-driven plastic turret.

## Spikes "B-24 Deception"

Statements that Consolidated flew B-24's to its Southwest plant to give a semblance of greater production on the occasion of the President's recent visit have been branded as "utterly false" by Tom M. Girdler, chairman of the company's board.

Refuting the remarks made before the Subcommittee of the Senate Committee on Education and Labor, Mr. Girdler wired Senator Pepper that bombers could not be flown in by the company for deception "for the simple reason that

the movements of planes in and out of the airport are controlled exclusively by the Army."

The accusations are "utterly false and unfounded," declared Chairman Girdler, "and they could do great harm to the war effort if allowed to stand uncorrected."

## CAB Cuts EAL Mail Pay

CAB has ordered a substantial reduction in the rate of mail payment to Eastern Air Lines, effective as of Oct. 1, 1942, amounting to about $773,000 a year. The board also urged the carrier to consider reduction in passenger rates.

The new rate of 0.3 mill per pound mile was made applicable to all Eastern's routes between New York and Miami, Chicago and Miami, New York and Brownsville and San Antonio, and various intermediate points.

In asking for passenger rate reduction, the board pointed out that for the year ended June 30, 1942, Eastern's average revenue per passenger mile was 5.21c. as compared with an average of 5.02c. for all other domestic carriers.

## Looks to Postwar Export

Major importance of the export trade as a prime factor in meeting postwar problems is foreseen by Aviquipo—Aviation Equipment & Export, Inc.—as the organization marks the start of its tenth year. The company, headed by Samuel Niedleman, formerly chief engineer of Bird Aircraft Corp., represents aircraft and engine companies, airlines, flying clubs, and government departments in operations abroad.

What to do with the industry's huge production capacity, surplus stocks, ready materials, and abundant trained personnel when peace comes is a question demanding careful planning today, states Mr. Niedleman, who points out that "we will have to 'go after' sales and service abroad when the United Nations' commissions no longer lay the business at our doors."

Aviquipo was the first to sign under the Export Control Act of 1935, receiving Department of State License No. 1. It is now maintaining its New York City staff and continuing its business despite the difficulties imposed by war, currently using its procurement facilities to service requirements of manufacturers working on government contracts, as well as handling assembly-work subcontracting.

The company has given new weight to the South American field. The war closed its Brussels and Hongkong offices. However, the manager of the latter still "carries on" at Chungking and Chengtu.

## Key Officers Take New Commands

Several changes in command are announced. First, Lt.-Gen. Frank M. Andrews has become chief of the United States Forces in the Middle East, while Lt.-Gen. George H. Brett has assumed the Caribbean Defense Command. Returning from the Southwest Pacific with Gen. Brett was Col. Ralph Royce, leader of the long-range raid on the Philippines, who now takes command of the Southeast training center.

Gen. Andrews goes to the Middle East from the Carribbean Defense Command, where he was the first to be placed in charge of combined land-sea-air forces. Joining the Signal Corps, Aviation Division, in 1917, he was commanding officer, Headquarters Air Force, Air Corps, 1935-39, and he is said to be one of the two or three officers who gave wholehearted support to the basic scheme of B-17 hemisphere defense first proposed by Boeing.

*U. S. Signal Corps photo*

**LT.-GEN. FRANK M. ANDREWS**
**Now Middle East Chief**

*Official USAAF photo*

**MAJ.-GEN. HENRY J. F. MILLER**
**Heads European ASC**

Further, Maj.-Gen. Henry J. F. Miller has been named to head the European theater Air Service Command, while Maj.-Gen. Walter H. Frank becomes commanding general of the ASC in this country. This is an exchange of commands to "spread" combat zone experience.

## Machine Tool Amendment

Machine tool manufacturers have been instructed to give special emphasis to aircraft requirements, in accordance with Amendment No. 3 to General Preference Order E-1-b, issued No. 5, by the WPB. The amendment gives new directions for scheduling machine tool deliveries to the armed services. Order E-1-b provides for apportioning of each producer's monthly deliveries for each type of tool, 75 percent to the services and 25 percent to other buyers. Without affecting this division, Amendment 3 increases deliveries of machine tools to the air services, their prime contractors, subcontractors, and other companies upon which the air services depend.

## Wright-Langley Rift Ended

After 28 years, the Smithsonian Institution, through its secretary, Dr. Charles G. Abbot, has acknowledged that the Wright brothers were the pioneers in airplane invention, not Dr. Charles Langley, former Smithsonian secretary. Dr. Abbot admitted that the Langley plane of 1903 could not have been flown successfully, thus ending a long dispute.

In 1914, incident to a patent suit between the Wright brothers and Glenn Curtiss, the Langley *Aerodrome* was taken from the National Museum, reconditioned, and fitted with a new engine. And it then made a number of takeoffs from the surface of Lake Keuka, New York. Supporters of the Wright claims asserted that some 35 changes in construction were made without which the Langley machine could not have flown at all.

Orville Wright refused to permit the original Wright biplane to be shown with the Langley machine at the National Museum, sent it instead to a British museum in 1928. It is expected that Dr. Abbot's report will clear the way for the return of the Wright plane to this country.

## Nick Craw Killed in Action

Col. Demas "Nick" Craw, of Charlottesville, Va., has been killed in action during occupation of North Africa. He was on a special mission through which it was hoped to avoid needless bloodshed. Col. Craw had long been a proponent of long-range bombers, which have now turned in such an enviable record. He had been in Egypt since the early stages of the war.

## NATTC to Chicago

Rear Adm. Albert C. Read, Jr., will operate the Naval Aviation Technical Training Command from Chicago instead of from the Bureau of Aeronautics, Washington—a further move toward decentralization.

Included is general supervision of all technical aviation training (mostly the trades that must be learned by enlisted men).

*Wide World photo*

**FRENCH LAUNCH 63-TON "SE 200"**

**From yard at Marignanne, France, comes SE 200, Gargantuan six-engine, 63-ton flying boat. Intended by Vichy for postwar trans-ocean travel, ship no doubt is now in Nazi hands. Specifications and data: Wing span, 171 ft.; length, 131 ft.; height, 32 ft.; power, six 1,500-hp. engines, make not named; cruising range 3,726 mi.; accommodations, crew of 8 and 40 passengers; freight capacity 13,200 lb. Completion of larger 70-ton flying boat is also reported.**

## Canada Builds 400 Planes A Month; U.S. Engines Used

From a production of 100 a year in 1939, Canada has increased its output to a present rate of 400 airplanes a month, or about 5,000 a year, according to a report by Canadian Munitions Minister C. D. Howe.

Production includes trainers, Avro *Lancaster* and de Havilland *Mosquito* bombers, other light bombers, night fighters, and reconnaissance planes. Tooling is underway for production of Curtiss dive bombers.

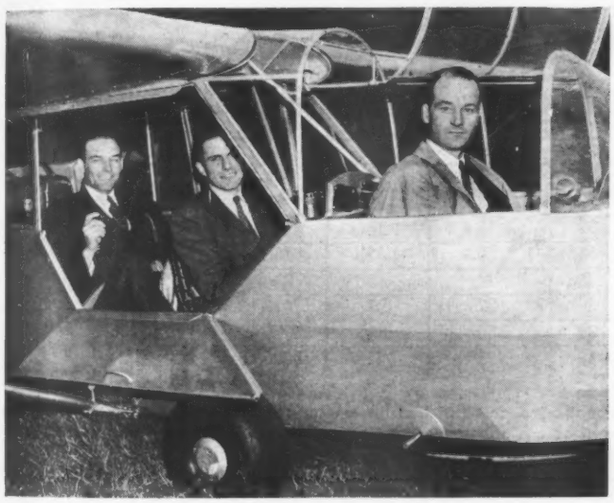
Mr. Howe said that the plywood *Mosquito* is turning out to be a very serviceable attack plane, and he implied that it is used by other than British forces.

Canada gets nearly all its airplane engines from the United States.

## Dedicate El Paso "Link"

Last link in a chain of scheduled airlines extending from Nome, Alaska, to Santiago, Chile, was forged in November when El Paso, Tex., dedicated its new municipal airport, thus closing the last main-line gap of the north-south airways route through the Western Hemisphere.

From the new port, which is equipped for immediate customs clearance, Continental Air Lines operates north to Denver, while American Airlines flies to Mexico City.



**FIRST-HAND INFORMATION**

L. Welch Pogue, recently appointed chairman of the Civil Aeronautics Board (left), in Piper glider just before start of a pickup flight. His pilot is Richard C. du Pont, president of All-American Aviation, Inc., which developed the glider pickup technique from its air mail pickup system. Passenger in center is Robert B. Bias, assistant to Chairman Pogue.

*International News photo*

**TOUR HIDDEN PLANT**

British underground airplane factory is viewed by American aviation leaders from tiny plant train, as "No Passengers" restriction is waived. Observers (l. to r.) are: Don Welty, general manager, Aluminum Corp. of America; H. R. Bloss, deputy director, British aircraft production; A. G. Herreshoff, of Chrysler; M. C. Marcus, vice-president, Bendix Corp.; unnamed British official; Sir Charles Bruce Gardner, chairman, Society of British Aircraft Constructors; J. Carlton Ward, Jr., president, Fairchild Engine & Airplane Corp.; and another unidentified Briton.

## British Have New Spitfire With Bigger Rolls Engine

An improved Vickers Supermarine *Spitfire* is now in action. It mounts the Rolls-Royce *Merlin* 61 engine instead of the 45 or 46. Old and new airframes are almost identical. Nose of the improved *Spitfire*, however, has been made slightly longer to take the larger powerplant.

Chief difference in appearance, apart from the nose, is in the wings; for underslung radiators are carried on both starboard and port. Radiator under the port wing, replacing a somewhat smaller oil-cooler, is associated with the engine intercooler, which is a feature of the two-stage supercharged *Merlin* 61.

Engine installations differ in following respects: Position of air intake changed slightly; over-all length somewhat greater, because of location of intercooler immediately aft of engine; exhaust stubs multiple type instead of triple ejector form; propeller a four-blader rather than the three-blader used on *Merlin* 45 and 46.

Armament consists of two cannon plus four machine guns mounted in the wings.

## PRODUCTION BATTLE CITATIONS

New firm names are added daily to that significant all-America team of companies honored for their exceptional performance on the war production front.

Right to fly the Army-Navy "E" flag with two stars has been won by the following firm:

**International Nickel Co., West Virginia plant.**

Honored with addition of one star to Army-Navy "E" flag are the following:

**Edward G. Budd Manufacturing Co.**
**Pratt & Whitney Aircraft Division, United Aircraft Corp.**
**South Bend Lathe Works.**

Latest winners of Army-Navy "E" flag:

**Aluminum Industries, Inc.**
**Axelson Manufacturing Co.**
**B. F. Goodrich Co.**
**Bell Aircraft Corp.**
**Eclipse Aviation and Pioneer Instrument Division, Bendix Aviation Corp.**
**Boeing Airplane Co., Midwest plant.**
**Bonney Forge & Tool Works.**
**Budd Wheel Co.**
**Cessna Aircraft Co.**
**Chain Belt Co.**
**Clarostat Manufacturing Co., Inc.**
**Continental Motors Corp., Michigan plant.**
**Edo Aircraft Corp.**
**Ex-Cell-O Corp.**
**Gisholt Machine Co.**
**General Electric Co., Schenectady works.**
**Independent Pneumatic Tool Co.**
**International Resistance Co.**
**Leece-Neville Company.**
**N. A. Woodworth Co.**
**National Broach & Machine Co.**
**Scott Aviation Corp.**
**Sheffield Corporation.**
**Solar Aircraft Co.**
**Sundstrand Machine Tool Co.**
**Sunnen Products Co.**
**Switlik Parachute Co.**
**Veeder-Root, Incorporated.**
**Ward Leonard Electric Co.**
**Westinghouse Electric & Manufacturing Co., five Pennsylvania plants.**
**William Sellers & Co.**

History and explanation of awards: The "E" flag was first introduced by the Navy in 1906 for excellence in gunnery, then later the honor was extended to include outstanding performance in engineering and communications. Most recently, as war engulfed Europe, the Navy further extended the "E" burgee award to embrace those plants and organizations turning in high performance in the production of ships, weapons, and equipment for the Navy. And finally, following Pearl Harbor, the present Army-Navy joint "E" award was born.

Those honored may fly the flag above their plants, and the employees receive silver oak and laurel-wreathed "E" pins. The original flag award represents outstanding production performance extending over a twelve-month period. For each additional six-month period of such excellence, a white star is bestowed to be flown on the earlier-awarded flag.

# 2 small POWER RELAY

**PROVEN BY TWO YEARS UNDER THE FIRE OF EXPERIE**

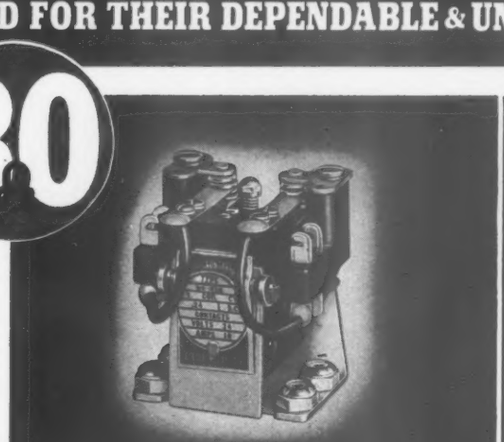
**ACCEPTED FOR THEIR DEPENDABLE & UNWAVERING PERFORMA**

## BO

BO and BJ power relays meet every known requirement for flight, firing and communication control.

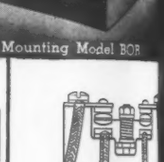
BO and BJ are Relay Veterans. They have seen two years on the firing line of experience ... on the sea ... in the air ... and on land. They have proven themselves durable and completely dependable.

BO and BJ have semi-balanced armatures which require minimum wattage to withstand shock and vibration up to 12 G ... they operate at temperatures of 120 plus or 50 minus ... they are corrosion resistant beyond specifications ... their weights are significantly low ... their dimensions are minute ... their double pole double throw design permits abundant contact arrangements ...



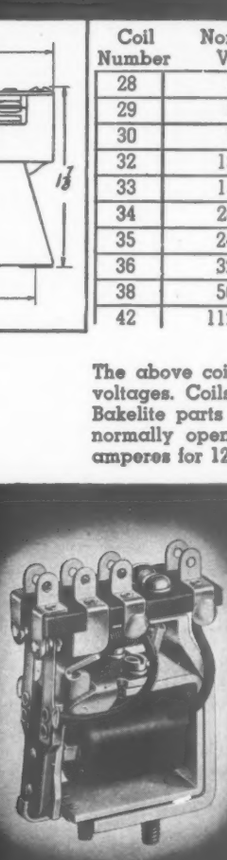
In Bakelite Mounting Model BOB

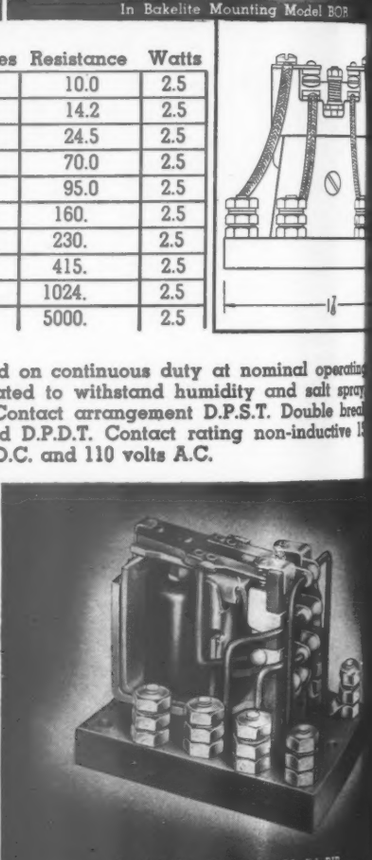
| Coil Number | Nominal Volts | Amperes | Resistance | Watts |
|---|---|---|---|---|
| 28 | 5.0 | .500 | 10.0 | 2.5 |
| 29 | 6.0 | .422 | 14.2 | 2.5 |
| 30 | 7.8 | .319 | 24.5 | 2.5 |
| 32 | 13.2 | .190 | 70.0 | 2.5 |
| 33 | 15.4 | .162 | 95.0 | 2.5 |
| 34 | 20. | .125 | 160. | 2.5 |
| 35 | 24. | .106 | 230. | 2.5 |
| 36 | 32. | .078 | 415. | 2.5 |
| 38 | 50. | .049 | 1024. | 2.5 |
| 42 | 112. | .022 | 5000. | 2.5 |



The above coil data is based on continuous duty at nominal operating voltages. Coils are impregnated to withstand humidity and salt spray. Bakelite parts are molded. Contact arrangement D.P.S.T. Double break normally open or closed and D.P.D.T. Contact rating non-inductive 5 amperes for 12 and 24 volts D.C. and 110 volts A.C.

## BJ



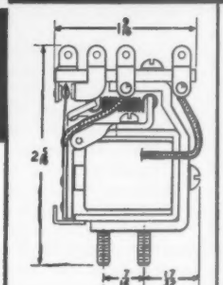


In Bakelite Mounting Model BJB

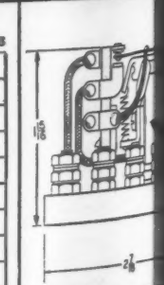
**....and they are INTERCHANGEABLE**

... variations in the mounting base can be made to make this relay widely interchangeable

**BO and BJ are *Accepted* and *Approved* RELAYS**



| Coil Number | Nominal Volts | Amperes | Resistance | Watts |
|---|---|---|---|---|
| 24 | 1.61 | 1.243 | 1.293 | 2 |
| 26 | 2.56 | 8003 | 3.270 | 2 |
| 28 | 4.07 | 4918 | 8.267 | 2 |
| 30 | 6.47 | .3093 | 20.90 | 2 |
| 32 | 9.92 | .2017 | 49.16 | 2 |
| 34 | 15.0 | .1332 | 112.6 | 2 |
| 36 | 25.4 | .0786 | 323.5 | 2 |
| 38 | 39.5 | .0506 | 780.6 | 2 |
| 40 | 59.6 | .0339 | 1738. | 2 |
| 42 | 86.3 | .0232 | 3725. | 2 |



The above coil data is based on continuous duty at nominal operating voltages. Coils are impregnated to withstand humidity and salt spray. Bakelite parts are XXXP laminated wax impregnated. Contact arrangement D.P.S.T. Double break normally open or closed and D.P.D.T. Contact rating non-inductive 5 amperes for 12 and 24 volts D.C. and 110 volts A.C.

**ALLIED CONTROL**

## CAA Technical Division Makes Progress Report

Among a number of important new devices in aviation just announced by the Technical Division of CAA is the seadrome day marker, which is floated on a rubber "doughnut" similar to that used for the seadrome night marker, mounting a distinctive plywood, rubber-covered symbol, either a circle or triangle, placed on a standard 6 to 9 ft. above water and visible from all angles.

Successful experiments have been made to produce an airplane windshield which can be effectively de-iced and is strong enough to withstand the impact of heavy birds in flight.

Various radio improvements have also been reported by CAA. The new high frequency two-course radio range, which combines simultaneous voice communication and sector identification, has reached the stage of actual installation. Radio teletype circuits and controls operated on a frequency modulation system bring inaccessible radio facilities and remote weather and traffic control posts under the direction of CAA men in the field.

Simple and less expensive radio fan marker monitors have been developed and are ready for installation. An automatic radio range monitor is now under development which not only serves as a warning to CAA airways workers when a radio range gets as much as 3 deg. off its proper setting, but also sends a distinctive aural warning to the pilot that the range is not on a proper bearing. Progress has been made in the instrument landing fields, with great implications for military flying, but the results are not made public. To prevent the most common of accidents during training, CAA has developed a highly effective stall warning device.

There are a number of new chemical combinations under study for speeding up the work of preparing usable landing surfaces. The War Department has specifically requested six such projects of the CAA.

## Urges Better Loading

Twenty-five thousand C-87 planes—the cargo version of the Consolidated B-24 bomber—could carry the freight now moved by American railroads which use 1,700,000 freight cars, Col. Edward S. Evans, president of the Evans Products Co., declared in an address to the Air Cargo Research Association in Los Angeles.

He said that if proper loading methods were used by airlines doing work for Army, the payloads could be increased by 33⅓ percent. A study should be made of containers used for shipping to reduce weight and regulate its strength to the strains to which it is subjected, he added. These two factors, coupled with the fact that it is much simpler to load a plane, lead him to believe the cost of air freight will be less than first-class rail freight.

## Flight Schools for Mexico

Washington (AVIATION Bureau)—Mexico will establish two pilot training schools similar to those being operated in this country by CAA, the State Department has announced.

MORE FIREPOWER FOR THE AAF

First group of Boeing B-17 "Flying Fortresses" to be outfitted and armed with increased fire power by Douglas Aircraft Company at a government-owned assembly plant "somewhere in the Southwest." The process, as exemplified by this instance, has proved invaluable in speeding American aircraft from the assembly lines to fighting fronts with the latest and most potent equipment.

# THE WASHINGTON WINDSOCK

By BLAINE STUBBLEFIELD

**Little was known** of air bases in eastern Russia till recently. The Russians didn't want to tell us because they think we are too gabby. Authorized persons have seen these bases recently and found them numerous, equal to our own best, and adequately equipped for snow removal.

**Alcan is an ugly word,** but it's the name of our new Alaska-Canada highway, already open, and being completed this winter. Officials say never a word, but everybody here believes that transport planes will shuttle the short jump between the north end of this road to Russian bases with great quantities of war supplies. The route would go far north of the Aleutians, so the Japs couldn't interfere even if they manage to stay there. Or, Russia could buy and fly the planes, which would not be attacked so long as the two countries are not at war.

**They were pals.** Long ago, Andrew J. Higgins built an airplane and young (Col.) John Jouett, who has quit the Aero Chamber to head Higgins' new aircraft division, flew it for him. Another young fellow came along and got a job flying the plane and was killed in it. Higgins gave the man's wife $5,000, all the cash he had at the time.

**A man with Willkie** on his trip around the world, said Gen. Claire Chennault told him that American Air Forces in China are in a position, and ready, to bomb Japan's industrial centers any time they can get enough airplanes and supplies.

**We had lost four** aircraft carriers at this writing. When the war started we had 7, had 11 more under contract—total 18. This program undoubtedly has been increased. We launched a new *Lexington,* which, when delivered, will give us four regular carriers in service. An unknown number of merchant and warships have been converted to flat tops. We are ahead of the Japs, who have lost six or seven of their original ten—outside of small conversions—which are about half the size of ours.

**Viva Mexico.** Enough war gear has gone south of the border to equip 500,000 soldiers. This includes a lot of airplanes, which are armed at the border and flown in by Mexican pilots. Mexico is planning air convoy for shipping in the Gulf.

**Confusion report.** A military magazine printed a story the other day saying the Commonwealth Air Training Scheme turns out 500,000 airmen a year, including 25,000 pilots, at 93 schools. We called up the embassy and asked if it was so. They read us the riot act for wanting to print war secrets, and complained that the military magazine had skated on the edge of treason. The next day we found the British press release from which the military magazine had taken the whole story. I say, cawn't you chaps get together?

**Not so much rubber** is being flown as you might suppose. It was assumed in some quarters that the Miami-Carribbean air route program was mainly to fly latex from wild jungle trees. Our stockpile of rubber will last till late next year; imports can move fast enough in surface ships.

**The Stubblefield award** goes to Rome Radio, which invites the RAF to keep on bombing the Italians. "Bombing is an excellent morale booster," it says. You can have it, Benito; we'll take a zombie.

# CALLING NAMES

**Harry Woodhead,** president of Consolidated was elected president of Vultee Aircraft. Vultee directors also elected I. M. Laddon, v. p. and g. m. of Consolidated, vice president of Vultee.

**Gerard Swope** has been selected as the sixth recipient of the Hoover Medal for "constructive public service in the field of social, civic, and humanitarian effort." He was also recently elected pres. of General Electric for the second time when Charles E. Wilson, his successor, was named vice-chairman of WPB.

**Thomas F. Kahoe, Lester H. Lancaster** and **John S. Robertson** have been named general superintendents of three of Pratt & Whitney's plants.

**Herbert O. Nelson,** formerly with Hill & Knowlton, public relations, has been named director of public relations for Interstate Aircraft.

**E. P. Barry,** formerly with Glenn L. Martin, has been named plant coordinator for Chicago Pneumatic Tool and will supervise production methods.

**Terrell C. Bonnie** has been appointed TWA's district traffic mgr. at Albuquerque, succeeding **John S. Winchell** who has been transferred to the Intercontinental Division; and **Clyde S. Fullerton** has been named director of a newly created training division of the line, with headquarters in Kansas City. **M. Denis Murray** was appointed district traffic mgr. in Washington and **E. T. Huber** in Boston.

**Elmer P. Guth** has joined the staff of Pesco field engineers. He was formerly with Waco, and before that with White Motor. He is a member of the SAE and the Institute of Aeronautical Sciences.

**George H. Tweney** has been appointed acting director of the Department of Aeronautical Engineering at the University of Detroit, while Prof. **George J. Higgins** is on leave of absence as a Lieutenant-Commander in the Navy.

**Charles Nelson, Jr.,** was appointed chief engineer of Ahlberg Bearing in charge of bearing design and development work.

**K. R. Van Tassel** has been appointed sales manager of the newly formed integral-horsepower motor section of G. E. and **D. A. Yates** has been placed in charge of the Lynn motor group. **D. L. Beeman** has been appointed engineer, industrial power section, and **R. S. Sage,** engineer, mining section.

**Lorenze Iversen** was elected member of the board of directors of All American Aviation, and the following directors were reelected: **Richard C. du Pont, Grover Loening, Richard P. Dunn** and **Charles W. Wendt.**

**Millard B. House** has been appointed controller of NWA; and NWA also announces the promotion of **Gordon MacLaren,** former N. Y. district traffic mgr. on leave with the Navy, to Lieutenant, senior grade.

**T. E. Tillinghast** has been elected pres. of United Aircraft Service Corporation, succeeding **Eugene E. Wilson** who resigned as pres. of the Service corporation.

**John Croft,** Flying Tiger who was credited with the destruction of two Japanese planes, has joined his AVG companion **Parker Dupuoy** as a Republic test pilot.

**Maj. William O'Dwyer,** Air Corps, has been appointed Acting Air Inspector of the newly created office of Air Inspector, Materiel Command, Army Air Forces.

**Col. T. B. Wilson,** transportation chief for Gen. MacArthur in the Southwest Pacific area, has received the honorary degree of Doctor of Aeronautic Science for "distinguished service in the field of aviation education" from Iowa Wesleyan College, where he was instrumental in setting up an air transportation course. TWA also announces that **Bart Pevear** of public relations and **Ronald Veeder,** traffic representative, have been commissioned first lieutenants and **C. R. Crome,** cooperative advertising mgr., and **Michael Corley,** reservations control representative, second lieutenants, all to join Col. Wilson's group.

Douglas Aircraft nominates for its "Team of the Month" **F. W. "Ted" Conant,** vice-pres. in charge of manufacturing, and **Edward L. Markham** of fuselage installations department, his partner in production.

**George Rentschler,** pres. of General Machinery Corp. and chairman of the Southeastern Shipbuilding Corp., and **William H. Houghton,** comptroller of Bendix, have been elected to the board of directors of Bendix Aviation.

**Catherine Hunzinga,** dubbed "War Cinderella" at Wright Aeronautical for taking over her brother's job as bench burrer when he was called to the Army.

**J. Gordon Hussey** is pres., **Frank Belcher,** vice-pres., **Stewart C. Williams,** secy. and treas., and **Verne Robinson** and **E. U. Wheelock** directors of Aero Services, Inc., plane salvagers for Army Air Forces and private concerns.

**Dan C. Hungerford** has been elected pres. and gen. mgr. of Aircraft Parts Development Corp. Before joining Aircraft Parts he was vice-pres. and a director of the Elastic Stop Nut.

**Frank J. Carter,** since 1938 general superintendent of Goodyear's Brazilian plant, has been appointed personnel mgr. in this country, succeeding **R. S. Pope,** recently made director of personnel.

**R. B. C. Noorduyn,** vice-pres. and gen. mgr. of Noorduyn Aviation Ltd., was elected pres. of the Air Industries & Transport Assn. of Canada, formerly the Air Transport Assn., succeeding **James Young,** pres. of Canadian Pratt & Whitney, whose term as director had expired. **C. H. Dickins,** gen. mgr. of Canadian Pacific Air Lines, was elected vice-pres., and **W. F. English,** asst. vice-pres. of TCA, was elected honorary secretary. **M. E. Ashton,** pres. of Wings, Ltd., was reelected honorary treasurer. Other directors: **J. N. Baird,** British Aeroplane Engines; **W. N. Deisher,** Fleet Aircraft; **P. C. Garrett,** de Havilland; **Grant MacDonald,** MacDonald Bros.; **C. R. Troup,** Canadian Pacific; and **W. B. Burchall** who is full-time executive secy., was reappointed.

**Harper MacNeill,** traffic representative, Trans-Canada, has been promoted to district traffic mgr. in New York, succeeding A. P. Wilson, who has been granted leave of absence to accept an appointment as pilot officer in the RCAF.

**Dr. Mordecai Ezekiel** has been appointed Executive Assistant to Vice-Chairman Charles E. Wilson, WPB.

**Charley Golenpaul,** sales executive of Aerovox was elected to his third term as chairman of the Sales Managers' Club.

**Capt. Sid. S. Pike,** former head of Skywriting, Inc., has been heard from, from "somewhere in the middle East," where he is serving with a bomb squadron.

## Reclassification Opens Aircraft Jobs

**TEAMWORK DOES IT**

**Handicapped only by small stature, Mrs. Elizabeth Laughlin has been found efficient as a drop hammer feeder in the Aircraft Components, Inc. plant. Heavy work is done by 6 ft. 4 in. operator Theodore Rothner.**

Plans for reclassification of jobs in preparation for employment of heretofore rejected personnel applicants is under way in Pacific coast aircraft plants. Three firms, Consolidated Aircraft Corp., North American Aviation Corp., and Aircraft Components, Inc., have announced that progress has been made.

Typical of the new attitude, precipitated by the growing manpower shortage, is the employment by Aircraft Components of Mrs. Elizabeth Laughlin, who is less than 5-ft. tall, as assistant to 6 ft. 4 in. Theodore Rothner, drop hammer operator. Mrs. Laughlin serves as feeder.

North American has listed 178 persons who are physically handicapped in one or more ways, including totally blind, deaf and persons with but one leg or one arm, now on its payrolls. Among the occupations listed for this group are machine operators, sheet metal workers, painters, welders, parts installers, tube benders, tool designers, inspectors, timekeepers, and storeroom clerks.

Officials report that the handicapped employees are performing their jobs to the complete satisfaction of their department heads. One man, who uses a wooden leg, is now a leadman in his department.

A rigid physical examination is required to determine exactly the limits within which a handicapped man or woman may be employed.

Consolidated's president, Harry Woodhead, has announced that each job in its plant is to be evaluated to find out what physical strength, aptitude and dexterity are needed to fulfill it effectively. When these are known, even blind persons who are otherwise capable of employment will be hired for such jobs as they can perform.

Dr. A. C. Dick, head of the company's medical department, is in charge of the new job survey.

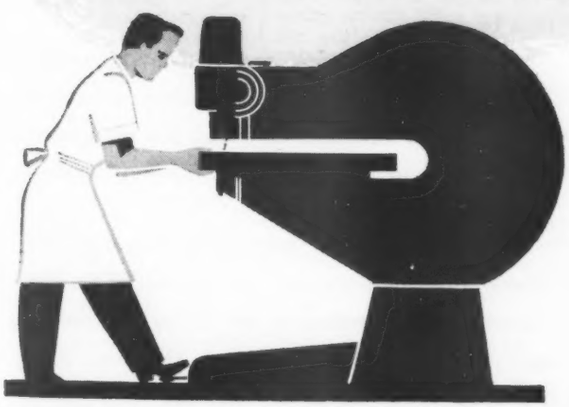
# ERCO

## Automatic Riveters

## Now Represented by

# AERO TOOL CO.

## On the Pacific Coast



**ENGINEERING RESEARCH CORPORATION** manufacturers of Erco Automatic Riveting Equipment, is now represented in the West by the Aero Tool Company.

Erco Riveters are the only single unit machines that punch, dimple and rivet, saving many hours and reducing multiple operations in aircraft construction. The trained Erco service staff of the Aero Tool Company is now at the disposal of Pacific Coast manufacturers.

**AERO TOOL COMPANY • 231 WEST OLIVE AVE., BURBANK**

# INDUSTRY IS ON AN EIGHT-DAY WEEK

Seven days a week America is doing one of the greatest jobs of production the world has ever known. We are living with one part of that job here at Alcoa, where over seventy thousand men and women are producing Aluminum in quantities that were mere fantasy yesterday.

But there's an eighth day tucked in among the few open spaces in the seven-day week. Engineers are able to squeeze in some important Imagineering about post-war products—planning that will help convert war jobs into peace jobs.

For instance:

Imagine what 1,000 pounds less weight in the automobile of the future would mean in performance, gas economy and tire life. Then engineer it down to the realization that 1,000 pounds *can* be taken off by using, say, 500 pounds of Aluminum per car.

Now translate possibilities such as these into your own business.

Aluminum costs less today. New methods, techniques, processes, and new forms of metal coming out of the war effort will all be available for the as-yet-untold possibilities in tomorrow's peacetime products and peacetime services.

Our eighth day is devoted to helping Imagineers throughout industry use the potentialities of Alcoa Aluminum in bettering the new ideas they are dreaming up. ALUMINUM COMPANY OF AMERICA, 2182 Gulf Building, Pittsburgh, Pennsylvania.

ALCOA ALUMINUM

## Plane Production Levels Off; Higher Output of Bombers Raises Value

Washington (AVIATION Bureau) — Aircraft production planning late last month was unsettled and, at press time all concerned except a few manufacturers who were up with or in front of their schedules were displeased.

Production by numbers of units went along much as planned for the three months July, August, September, but in October it fell off by some 250 planes.

The War Production Board and the President attributed this drop to one thing: the shift from light combat and training craft to heavy bombers. The board, by reporting production in dollar value instead of in units, was able to announce an increase of 10 percent for September. In addition to the shift to heavy bombers, the air services and Ordance are shifting to heavier armor, higher power guns, and all-round harder-hitting qualities.

Airplane production was not going ahead to suit the services or the board. The President had found it necessary to explain to the public why the 60,000 goal would not be reached this year, and then the board had to shift from units to dollars to avoid stirring up a murmur.

In fact, the unsatisfactory airplane program was one reason why, three months back, WPB Chairman Donald Nelson found it necessary to bring in two vice-chairmen on materials and production, C. E. Wilson and Ferdinand Eberstadt. It was recalled that Wilson was made personally responsible for aircraft production and that Merril C. Meigs, head of WPB's aircraft section, resigned

There is no report in Washington of blame for any airplane, engine or propeller manufacturer. President Roosevelt himself was delighted with what he saw of the industry, and so are most other war leaders.

The shift to heavy airplanes, as explained by both the President and WPB, is the result of developing strategy rather than of any errors of judgment. In fact it is regarded as good news that the industry is adjusting so readily to experience at the fronts.

But that is not the whole story. The disbalance of material supplies of recent months took its toll of airplane output. Some plants were down as much as 25 and 30 percent for lack of supplies. In addition to their old shortages, plants ran out of aluminum and other metal shapes, special steels and alloys. The output of propellers is barely keeping up with engines, and it seems likely it will have to be boosted to meet the expected rise in the airplane production rate.

Definite measures have already been taken to balance the flow of materials so that airplane production can catch up with the rate it should have attained by early 1943.

But that still will not be enough, it is said here. The military importance of airplanes is increasingly recognized from day to day, and the administration is in the process of again increasing the program in some categories.

Since the entire supply of materials is allocated to various equipment and weapons now, there is no way to increase the airplane program without taking materials away from something else. This is difficult, because ordnance and shipping officers do not want to give up anything. It is unofficially said that the high command has its eye on tanks, among other munitions, for curtailment in favor of aviation.

### New Interstate Plant

Conversion of the Arlington Furniture Company's Midwest plant to the manufacture of a new type plastic-plywood airplane for the United States Navy was announced by the Interstate Aircraft & Engineering Corp. The West Coast firm has leased the property from Defense Plant Corp., and is preparing what was called the "longest assembly line in the furniture industry" for mass production of the new Navy plane, details of which have not been released.

Subcontractors for the new plant will be the Rudolph Wurlitzer Company, piano and organ manufacturers, and a Singer Sewing Machine plant. Both firms are converting production facilities to manufacture assemblies for the new Interstate plane. The West Coast plant of the Interstate Corp. will continue production of hydraulic units and armament.

Personnel changes prompted by establishment of the Midwest plant, announced by President Don P. Smith, include C. W. Burst, plant manager; W. E. Hirtensteiner, vice-president in charge of producion; and Manley R. Sackett, personnel manager. The latter is replaced in the West by Thomas Trevorrow. L. B. Cameron is now secretary and treasurer and Walter A. Hite is vice-president in charge of engineering.

### GM Steps Up Production

Over half the war manufacturing at General Motors' 104 plants is for the air forces of the United Nations, the company reports. The current rate of war production is more than $7,000,000 a day. This includes the liquid-cooled Allison engine which powers airplanes now numbered in five figures. Allison received its first quantity order for engines in 1939.

Two other divisions—Buick and Chevrolet—are in production on Pratt & Whitney engines. Eastern Aircraft Division, with five converted automobile plants, is producing the Grumman F4F *Wildcat* fighter and the TBF *Avenger* torpedo bomber, while Fisher Body is turning out airframe assemblies for North American B-25 bombers. Fisher is also producing parts and instruments for the Boeing *Flying Fortress.*

A new type variable pitch propeller is in production at Aeroproducts division and the Frigidaire division makes propellers, aircraft machine guns, bomb rack and harness assemblies, auxiliary gas tanks, hydraulic valve assemblies and other parts.

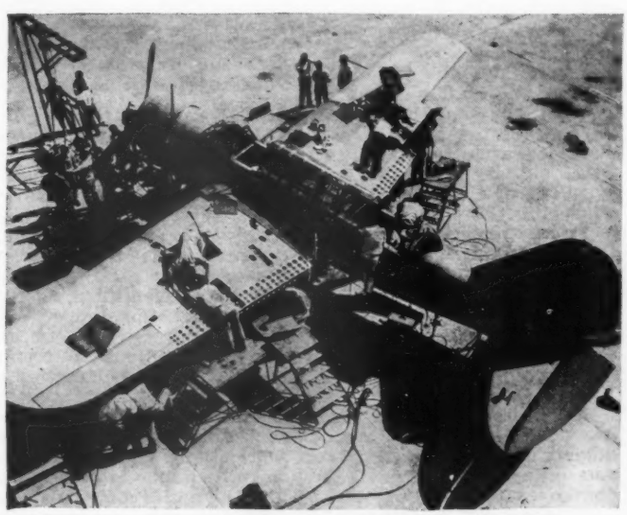
### Special WPB Group For Aircraft Industry

Washington (AVIATION Bureau)—To assist in doubling aircraft production during 1943, WPB Chairman Donald M. Nelson is setting up a "little WPB" for the aircraft industry under the chairmanship of Charles E. Wilson, former president of the General Electric Company and now vice-chairman of WPB in charge of production.

Members of the board thus far selected to work with Mr. Wilson include Harold Talbot, head of WPB's Aircraft Production Division; Rear Adm. Ralph E. Davison, Navy Bureau of Aeronautics; and Maj.-Gen. Oliver Echols, A.A.F.

Next year's production schedule involves more than mere numerical doubling of units, for tonnage of aircraft to be built will also be increased. One of the prime jobs of the committee, Mr. Nelson explained, will be to expedite materials needed to make design changes which will result from experience gained in the field. Offensive warfare, he pointed out, increases the number of such changes which must be made.

Additional plant facilities may be required to meet the production schedule, Mr. Nelson said, but new construction will not be inaugurated until all existing facilities are used.



FINAL CHECK-UP

Workers swarm over a new Brewster dive bomber, giving it final touches and rigid inspection before dispatching it to a fighting front. Note the perforated dive brakes along the trailing edge of the wing.

## Jouett Heads Higgins Aviation Division; Aero Chamber Hard Hit by Resignations

Washington (AVIATION Bureau)—Reorganization of the Aeronautical Chamber of Commerce, following a shake-up of recent weeks, probably will be completed around the first of the year. Sources inside the Chamber said they believed the organization would be more efficient and more useful in future than it has ever been.

Col. John H. Jouett resigned when reorganization started and joined Andrew J. Higgins, combat boat builder, as head of the new aviation division which has a contract to build 1,200 cargo airplanes. Col. Jouett was a pilot in the World War, and has been a successful aviation executive ever since. Seemingly everybody, in the Chamber and out of it, praised his work there.

By late last month, nearly all major members of the Chamber had resigned, and were holding meetings here to discuss reorganization. Some had advocated abolition of the old group, and the setting up of a new one.

Deliberations were closed to the press, but participants had complained: (1) That dues were getting too high, since they are prorated on the manufacturer's output, (2) the Chamber was expanding out of proportion to the services it rendered, (3) the Chamber failed to furnish members adequate information about Army, Navy and government war control orders, (4) many air schools, parts manufacturers, and other "outsiders" and non-technical members had been admitted, so that airframe, engine, and propeller makers felt the Chamber was no longer representative of their interests.

Persons in the Chamber contend the fault was not all theirs. They said the various interests in the industry had disagreed as to group policy: that military officials had stood in the way of their aims; and that the war itself had inevitably thrown the Chamber's relations with its members out of balance.

## Bell to Vote on Retirement Plan

Bell Aircraft Corporation has called a special stockholders meeting for Dec. 16 to vote on a retirement plan for employees reaching age 60.

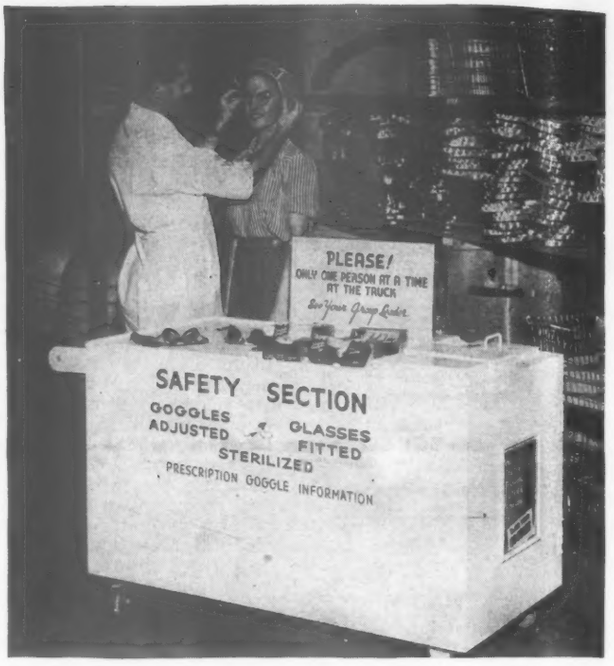
If approved, the plan will become effective Dec. 31, and will include 800 employees.

In a letter to stockholders, Lawrence D. Bell, president, said, "The directors believe it is distinctly to the interest of the company to recognize key employees who are giving their best years to the company, by making some provision for their welfare after retirement. This should result in greater effort and efficiency."

## Cargo Reseach Group Set up By Coast Builders, Carriers

Aircraft builders and transport operators on the West Coast have organized the Air Cargo Research Association, with Thomas Wolf, vice-president of traffic, Western Air Lines, as chairman. Other officers are: J. F. Hall, North American Aviation, first vice-chairman; Gordon Brown, Douglas Aircraft Co., second vice-chairman; J. B. Sheehan, Lockheed Aircraft Co., secretary-treasurer; and W. A. Lippman, secretary.

Purpose is to recommend procedures to promote efficiency.




TRAVELING SAFETY SHOP

Safety Attendant Nell Tierney fits new safety glasses for Ruth Crump at Vega Aircraft Corp. The special "goggle cart" was designed to promote wearing of eye protectors and to give Vega workers better service.

## ASSEMBLY LINES . . . By Dorsey Adams

**Packard says** it has a long lead over all other war plants in the country in the total number of honors to individual workers awarded to date by Donald M. Nelson's War Production Drive Headquarters for suggestions to speed American war production. For the second consecutive time, Packard topped the nation in number of Washington awards for production shortcuts. Winning suggestions from Packard war workers will speed their output of Rolls-Royce aircraft engines for American *Warhawks* and British *Spitfires and Hurricanes,* and of Packard marine engines for PT boats.

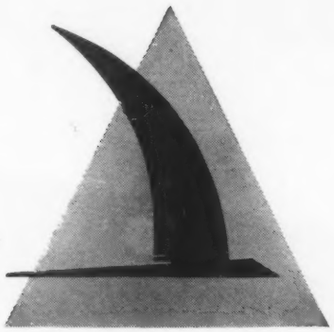
**Thin sheets of waterproof film** are speeding the flow of airplanes and other military equipment to the United State services. Goodyear chemists in cooperation with engineers of the Peerless Photo Products Co. have developed an emulsified Pliofilm which has the property of maintaining its exact size under all conditions of wetting and handling. Known as Transphoto film, it is being used throughout the aircraft and other industries to speed fabrication of templates for war-expanding factories, saving thousands of man-hours needed to make the templates. Two distinct advantages claimed for the Pliofilm process in cutting time for production of military equipment are: (1) No initial investment for equipment is required aside from trays or shallow tanks to hold the liquids in which the transfer sheets are immersed, and (2) the process can be used anywhere without regard for light or sun exposure.

**Some 2,000 workmen** are busy with the manufacture of metallurgic as well as plastic products at the firm of Impasal Metalurgica y Plastica in Buenos Aires. In September of 1941 the original design for a low-winged plywood trainer was developed by this firm. At the end of October the first experimental airplane, IMPA RR-11, was completed. The lack of steel and light alloys induced the concern to eliminate them as far as possible, which resulted in more economical construction, rapidity of fabrication, and ease of maintenance. The RR-11 is a low-wing cantilever monoplane, built entirely of wood. The landing gear is monopost cantilever type using rubber shock rings which work on compression. The plane is powered by a 65-hp Lycoming engine, which gives it a speed of 162 kph; cruising speed, 155 kph; range of 5 hr; ceiling, 5,000 meters.

**"Aero Recovery" grades of lumber** from which pieces of aircraft quality can be "recovered" by remanufacture, had maximum prices set up by OPA in Amendment No. 2 to Maximum Price Regulation 109, which covers aircraft spruce lumber.

**Several suggestions** which won prizes in Northrop's War Production Drive Suggestion Contest were forwarded to Washington for entry in the national contest and three of them received awards of Honorable Mention and for Individual Production Merit in the national competition. The three Norcrafters' suggestions were: Tubing cutter; multiple saw stop; sketch covering gas tank installation. Considerable difficulty was experienced in assembling and adjusting bomb bay doors on the V-72 until a remedy was found. Drawings were prepared of wooden frames that could be fitted in the front and rear of the bomb compartment to hold the doors in the proper position while adjusting was done. These frames save at least five man-hours per plane.

**From Lisbon,** Spain, comes the report of the successful use of cork tires for airplane landing gear after a trial flight authorized by the Military Aviation Command. The plane took off and landed normally on the tires invented by Adalberto Teles Monteiro. The test pilot reported that he noted only a slight vibration on landing and taking off and Monteiro says that the trouble can be eliminated.



# Two engineering advancements that will speed U.S. mastery of the skies

WHAT FOLLOWS is submitted by the men who comprise the "Northrop group"... men devoting every workable hour to hurrying the design and construction of U. S. warplanes ...men who claim no special credit for our country's progress toward air victory.

The U. S. Air Program is rolling. Here are two new engineering techniques that are speeding U. S. progress in developing new designs. And converting these designs into finished fighting planes *faster*.

First, may we tell you about *"Heliarc" welding?* Telling about this process cannot give aid to the enemy because it depends on the strange gas *Helium*—of which the U. S. A. has 98% of the world's supply.

Before this new development, natural aircraft metals such as magnesium and stainless steel were difficult to fabricate into aircraft structures—because it was not practical by ordinary methods to arc-weld two pieces of such metal together.

Engineers at Northrop, some months ago, discovered that *these metals under a Helium jet become weldable.* Northrop has turned the process over to the industry. It removes one hurdle on the road to the all-welded airplane.

The second new technique concerns a method of *faster tooling* for production of new-design U. S. airplanes. If we can *tool faster* than the Axis we can get new improved U. S. fighters and bombers into the air while the enemy's new designs are still unfinished in his plants.

*And* WE ARE *tooling faster. For example, from the Northrop group has come a new technique of template making that* SAVES THOUSANDS OF MAN HOURS *in tooling for a typical new U. S. design. This process saves five weeks in getting a new U. S. fighter onto the battlefront. As with Helium welding, this process has been turned over to the entire aircraft industry.*

These are merely examples. Additional new processes and new devices are coming from Northrop and also from other aircraft companies. And every major development is made available to all U. S. airplane builders. It is one reason the U. S. airplane-building program is getting places today.

**NORTHROP AIRCRAFT, *Inc.***

*Northrop Field, Hawthorne, California*

MEMBER AIRCRAFT WAR PRODUCTION COUNCIL, INC.

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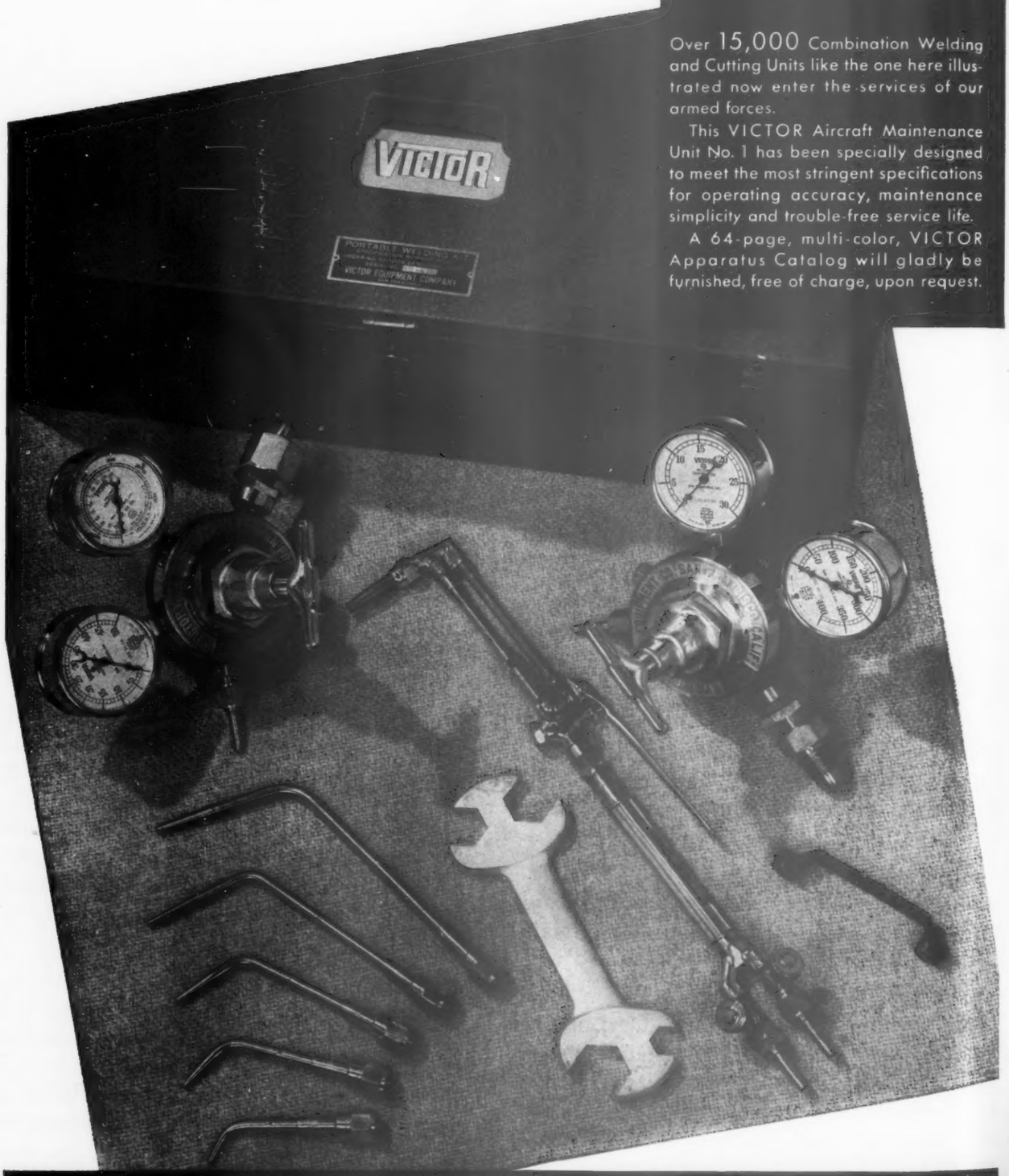
Over 15,000 Combination Welding and Cutting Units like the one here illustrated now enter the services of our armed forces.

This VICTOR Aircraft Maintenance Unit No. 1 has been specially designed to meet the most stringent specifications for operating accuracy, maintenance simplicity and trouble-free service life.

A 64-page, multi-color, VICTOR Apparatus Catalog will gladly be furnished, free of charge, upon request.

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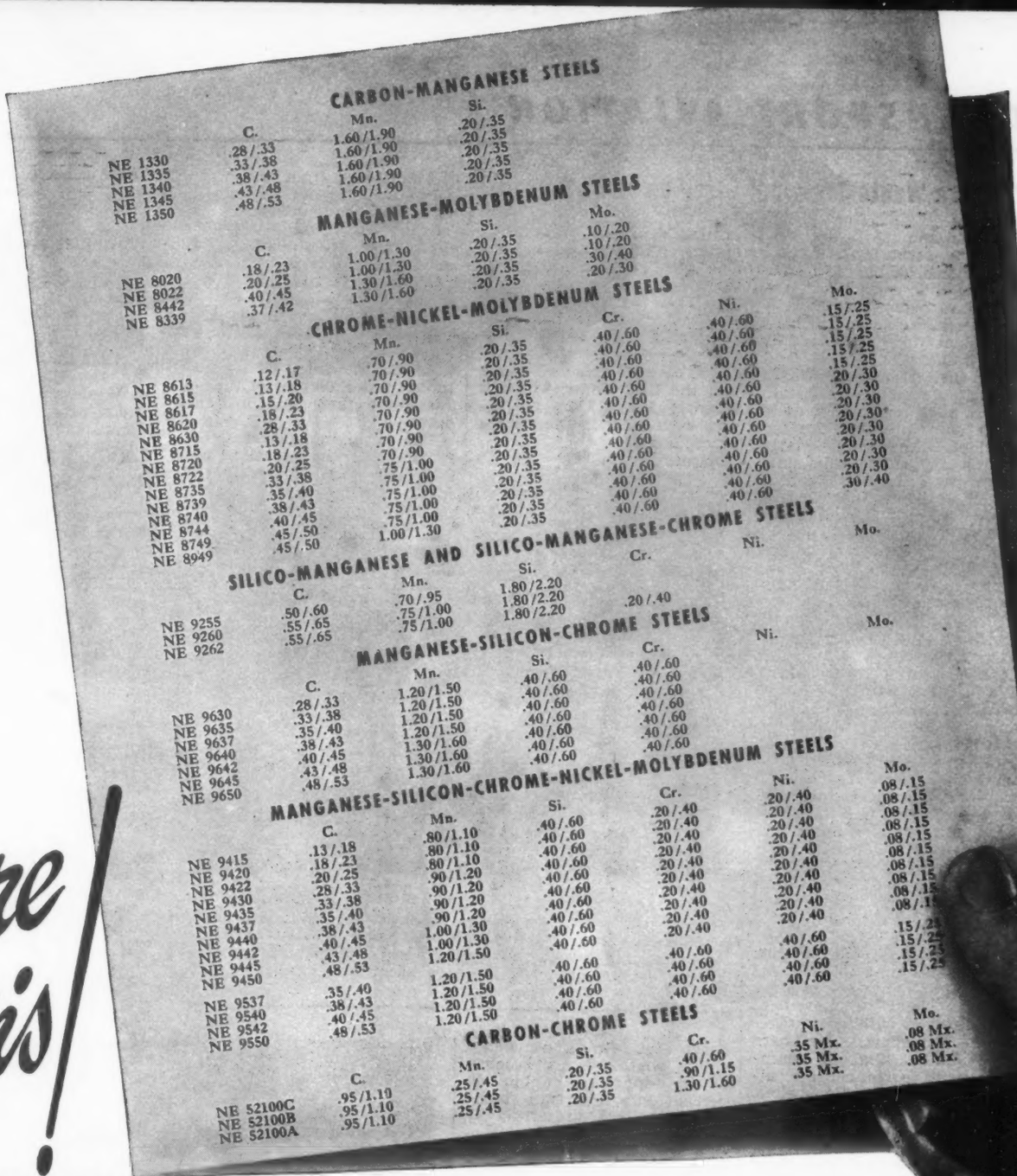

CARBON-MANGANESE STEELS

| | C. | Mn. | Si. |
|---|---|---|---|
| NE 1330 | .28/.33 | 1.60/1.90 | .20/.35 |
| NE 1335 | .33/.38 | 1.60/1.90 | .20/.35 |
| NE 1340 | .38/.43 | 1.60/1.90 | .20/.35 |
| NE 1345 | .43/.48 | 1.60/1.90 | .20/.35 |
| NE 1350 | .48/.53 | | |

MANGANESE-MOLYBDENUM STEELS

| | C. | Mn. | Si. | Mo. |
|---|---|---|---|---|
| NE 8020 | .18/.23 | 1.00/1.30 | .20/.35 | .10/.20 |
| NE 8022 | .20/.25 | 1.00/1.30 | .20/.35 | .10/.20 |
| NE 8442 | .40/.45 | 1.30/1.60 | .20/.35 | .30/.40 |
| NE 8339 | .37/.42 | 1.30/1.60 | .20/.35 | .20/.30 |

CHROME-NICKEL-MOLYBDENUM STEELS

| | C. | Mn. | Si. | Cr. | Ni. | Mo. |
|---|---|---|---|---|---|---|
| NE 8613 | .12/.17 | .70/.90 | .20/.35 | .40/.60 | .40/.60 | .15/.25 |
| NE 8615 | .13/.18 | .70/.90 | .20/.35 | .40/.60 | .40/.60 | .15/.25 |
| NE 8617 | .15/.20 | .70/.90 | .20/.35 | .40/.60 | .40/.60 | .15/.25 |
| NE 8620 | .18/.23 | .70/.90 | .20/.35 | .40/.60 | .40/.60 | .15/.25 |
| NE 8630 | .28/.33 | .70/.90 | .20/.35 | .40/.60 | .40/.60 | .20/.30 |
| NE 8715 | .13/.18 | .70/.90 | .20/.35 | .40/.60 | .40/.60 | .20/.30 |
| NE 8720 | .18/.23 | .70/.90 | .20/.35 | .40/.60 | .40/.60 | .20/.30 |
| NE 8722 | .20/.25 | .75/1.00 | .20/.35 | .40/.60 | .40/.60 | .20/.30 |
| NE 8735 | .33/.38 | .75/1.00 | .20/.35 | .40/.60 | .40/.60 | .20/.30 |
| NE 8739 | .35/.40 | .75/1.00 | .20/.35 | .40/.60 | .40/.60 | .20/.30 |
| NE 8740 | .38/.43 | .75/1.00 | .20/.35 | .40/.60 | .40/.60 | .20/.30 |
| NE 8744 | .40/.45 | .75/1.00 | .20/.35 | .40/.60 | .40/.60 | .30/.40 |
| NE 8749 | .45/.50 | 1.00/1.30 | | | | |
| NE 8949 | .45/.50 | | | | | |

SILICO-MANGANESE AND SILICO-MANGANESE-CHROME STEELS

| | C. | Mn. | Si. | Cr. | Ni. | Mo. |
|---|---|---|---|---|---|---|
| NE 9255 | .50/.60 | .70/.95 | 1.80/2.20 | | | |
| NE 9260 | .55/.65 | .75/1.00 | 1.80/2.20 | .20/.40 | | |
| NE 9262 | .55/.65 | .75/1.00 | 1.80/2.20 | | | |

MANGANESE-SILICON-CHROME STEELS

| | C. | Mn. | Si. | Cr. | Ni. | Mo. |
|---|---|---|---|---|---|---|
| NE 9630 | .28/.33 | 1.20/1.50 | .40/.60 | .40/.60 | | |
| NE 9635 | .33/.38 | 1.20/1.50 | .40/.60 | .40/.60 | | |
| NE 9637 | .35/.40 | 1.20/1.50 | .40/.60 | .40/.60 | | |
| NE 9640 | .38/.43 | 1.30/1.60 | .40/.60 | .40/.60 | | |
| NE 9642 | .40/.45 | 1.30/1.60 | .40/.60 | .40/.60 | | |
| NE 9645 | .43/.48 | 1.30/1.60 | .40/.60 | .40/.60 | | |
| NE 9650 | .48/.53 | | | | | |

MANGANESE-SILICON-CHROME-NICKEL-MOLYBDENUM STEELS

| | C. | Mn. | Si. | Cr. | Ni. | Mo. |
|---|---|---|---|---|---|---|
| NE 9415 | .13/.18 | .80/1.10 | .40/.60 | .20/.40 | .20/.40 | .08/.15 |
| NE 9420 | .18/.23 | .80/1.10 | .40/.60 | .20/.40 | .20/.40 | .08/.15 |
| NE 9422 | .20/.25 | .80/1.10 | .40/.60 | .20/.40 | .20/.40 | .08/.15 |
| NE 9430 | .28/.33 | .90/1.20 | .40/.60 | .20/.40 | .20/.40 | .08/.15 |
| NE 9435 | .33/.38 | .90/1.20 | .40/.60 | .20/.40 | .20/.40 | .08/.15 |
| NE 9437 | .35/.40 | .90/1.20 | .40/.60 | .20/.40 | .20/.40 | .08/.15 |
| NE 9440 | .38/.43 | .90/1.20 | .40/.60 | .20/.40 | .20/.40 | .08/.15 |
| NE 9442 | .40/.45 | 1.00/1.30 | .40/.60 | .20/.40 | .20/.40 | .08/.15 |
| NE 9445 | .43/.48 | 1.00/1.30 | .40/.60 | .20/.40 | .20/.40 | .08/.15 |
| NE 9450 | .48/.53 | 1.20/1.50 | | | | |
| NE 9537 | .35/.40 | 1.20/1.50 | .40/.60 | .40/.60 | .40/.60 | .15/.25 |
| NE 9540 | .38/.43 | 1.20/1.50 | .40/.60 | .40/.60 | .40/.60 | .15/.25 |
| NE 9542 | .40/.45 | 1.20/1.50 | .40/.60 | .40/.60 | .40/.60 | .15/.25 |
| NE 9550 | .48/.53 | 1.20/1.50 | .40/.60 | .40/.60 | .40/.60 | .15/.25 |

CARBON-CHROME STEELS

| | C. | Mn. | Si. | Cr. | Ni. | Mo. |
|---|---|---|---|---|---|---|
| NE 52100C | .95/1.10 | .25/.45 | .20/.35 | .40/.60 | .35 Mx. | .08 Mx. |
| NE 52100B | .95/1.10 | .25/.45 | .20/.35 | .90/1.15 | .35 Mx. | .08 Mx. |
| NE 52100A | .95/1.10 | .25/.45 | .20/.35 | 1.30/1.60 | .35 Mx. | .08 Mx. |

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# THE LATEST AND COMPLETE LIST OF NATIONAL EMERGENCY (NE) STEELS*

If we can help you in selecting and applying these steels to your requirements, don't hesitate to call on us. The services of our metallurgists are freely at your disposal. This offer is open to every user of Carnegie-Illinois Steels and to every manufacturer of war equipment.

**As published September, 1942 by the American Iron and Steel Institute, as "Contributions to the Metallurgy of Steel," Pamphlet No. 8—Supplementary National Emergency Steels.*

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UNITED STATES STEEL

## Panagra Wants Terminal Stations in U. S.

Washington (AVIATION Bureau)—A serious air transport bottleneck has developed between this country and the Caribbean region. One obvious reason is lack of sufficient equipment to move bulging war traffic.

The Civil Aeronautics Board recently issued an invitation to any qualified companies to apply for route certificates.

Evidently the board believes there might be operators suitably situated who could take equipment from other services for new routes which it might authorize. CAB invited foreign applicants as well as domestic.

Twelve or fourteen applications already had been received at this writing. Among them were Eastern Air Transport, KLM (Royal Dutch Air Lines), British West Indian, TACA (associated with BWI), National Airlines of Florida and the Gulf, and others.

It is expected of course that Pan American Airways contend that if it were given the necessary equipment, it could carry the traffic with less overhead cost than would be incurred by a number of newcomers. Officials of CAB decline to comment in advance.

The invitation to make applications for Caribbean routes is in reality a move to make a survey of the bottleneck, and to determine to what extent equipment on existing services could be moved to new services with advantages to the war effort. The board fully realizes that all equipment and personnel are already employed. No specific routes were set up in the invitation. Hearings will bring out facts as to the need for additional service and these might influence the War Production Board and the Army to allocate more new planes to any new services that may be established.

Another factor in the inter-American air bottleneck is an action instituted by CAB to determine whether the certificate of Pan American-Grace should be amended to include one or more termini in the United States, with choice between Miami, Tampa, New Orleans, Brownsville, El Paso, or Los Angeles.

Panagra operates between Balboa, C. Z., and Buenos Aires via the West Coast of South America. Panagra is owned 50 percent by W. R. Grace Company and 50 percent by Pan American Airways. Panagra's natural desire for a terminal in the United States proper is augmented by the fact that much of its traffic must come to it over Pan American's routes southward out of the U. S. The two associated companies are said to have had disagreements over this question, and over the division of traffic between the West Coast, and the East Coast, which is flown by PAA. They will oppose each other in the board's proceedings.

According to the board's order, the Grace ownership claims that Panagra, because of the opposition of its 50 percent Pan American stockholders, is not authorized by its directors to make application for an amendment providing for a Panagra terminal in the U. S. Thus, the action was initiated by the government.

WOMEN TRAIN FOR AIRLINES

Feminine voices will soon be heard on the air lines' air waves, as is shown by this group of students at United Air Lines' Boeing School of Aeronautics, where the young women are training to become teletype and radio operators, to work alongside men in the company's communications centers.

## Military Return Flights Bring U. S. Vital Goods

Now it can be told that the Army's Air Transport Command is flying strategic goods on return trips to the United States. The announcement was withheld by the Army's censor until substantial shipments of several badly needed materials had built up stocks within the country.

The assembly system worked out by the Bureau of Economic Warfare with its branches all over the world made this service possible. For example, BEW set up stations in the Far East, where scarce metals are assembled from scattered points in China for air transport to the United States.

China National Aviation (Pan American Airways) carries bristles, tungsten, silk and tin to airports in China, from where they are taken to this country by Army or Navy. In eight weeks, 150 tons of these items plus 70 tons of tungsten were moved from China to India. Later, 98 tons of tungsten were flown out in ten days.

The Army transport system includes oversea operations by United Air Lines, Eastern Air Lines, TWA, American Airlines and others, furnishing their own personnel and using government-owned equipment. The Navy has contracts with American Export Airlines and others.

## Airlines Radio School

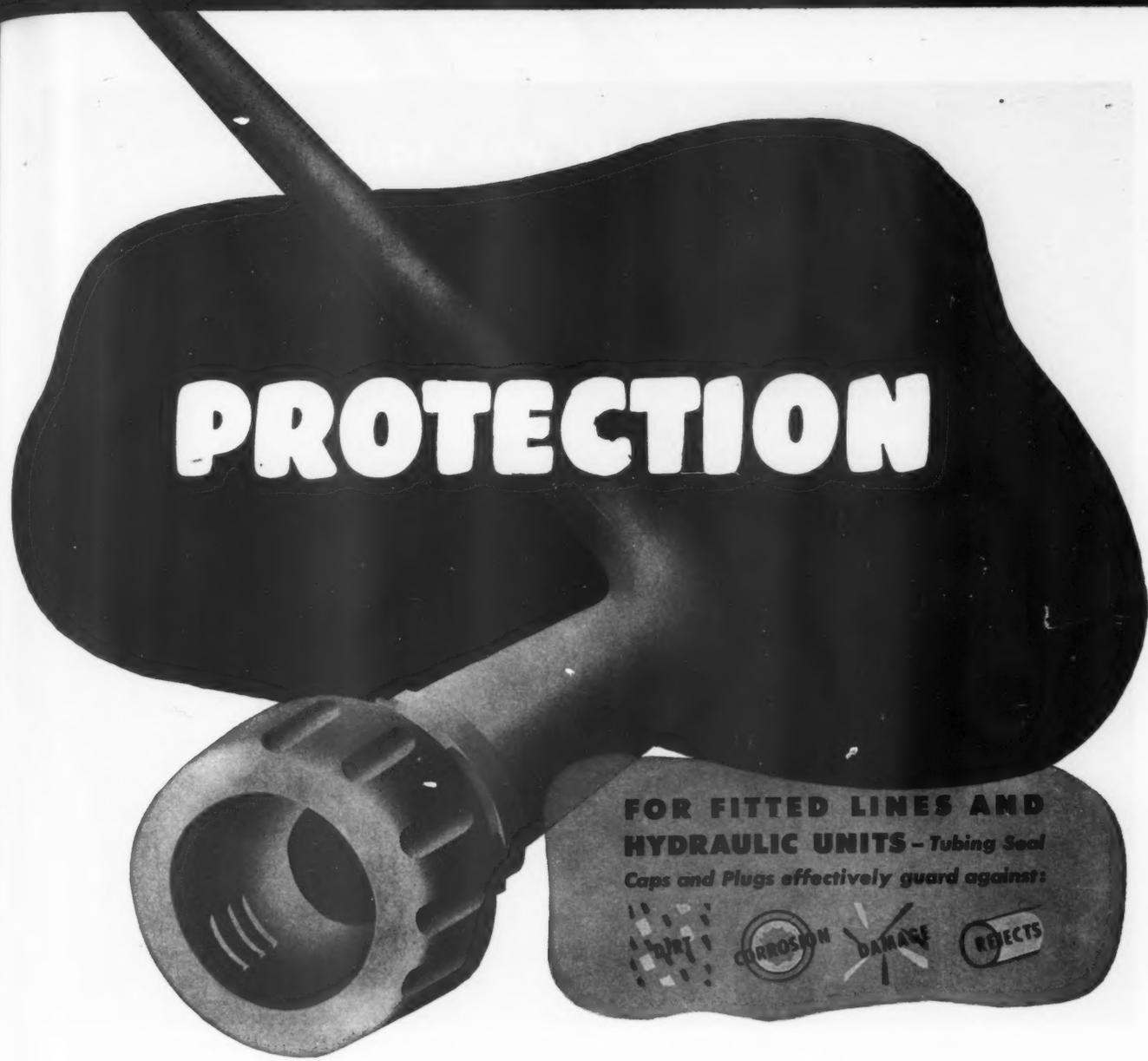
At Wesleyan College, Iowa, a radio extension course in air transportation to prepare students for job opportunities in the coming flying age is under way. Nearly 20,000 students regularly around classroom radios in Iowa, Illinois and Missouri to hear nationally known aviation authorities explain how the airplane in the postwar period will change the living habits and standards. The Wesleyan Aviation Course, established in collaboration with Transcontinental and Western Air, will continue through April.

## All-Cargo Flights Here

United Air Lines' Flight 15 is operating as an all-cargo trip between New York and Salt City as a means of expediting critically needed war materials. United had experimented with all-cargo flights in the past, with the intention of gaining experience for future use. Eastern Air Lines also is making a daily cargo trip between New York and Miami.

ALL-CARGO ROUTE TO SOUTH AMERICA

Unloading at Lima, Peru, is a Panagra plane operating on the first international air cargo service to be certified by the CAB. Specially fitted to carry only freight, the planes maintain schedules between Balboa, C. Z., Lima and intermediate points. Up to 15 tons of merchandise have been moved in a week since the service was inaugurated.




**RE-USABLE MANY TIMES,** being of cadmium plated metal, Tubing Seal Caps and Plugs are the most efficient, most economical protectors available, are easily and speedily spun on to fitted lines and hydraulic units, and tightened by hand. They seal under pressure, completely protect couplings, BT nuts, threads, beaded or flared ends.

Leading aircraft plants* use and *re-use* Tubing Seal Caps and Plugs to completely seal out dirt, dust, moisture, to prevent corrosion and handling knocks-and-shocks, to reduce rejects, and, when desirable, to seal fluids in hydraulic lines and units. Available for Parker and SAE (AN) fittings. Send for 10 page file size booklet "Tubing and Pipe Protection Methods."

**TUBING SEAL-CAP, INC.**
215 W. 7th STREET, LOS ANGELES
East. Representative, 428 New Center Bldg., Detroit

**TODAY it may be an anti-tank gun, stripped for check-up... tomorrow, the still-warm "heart" of a fighter plane. So it goes. Fighting equipment gets tough treatment in modern warfare. So the need for frequent servicing and constant parts replacement is understandable.**

**But there is one vital part which maintenance men seldom have to touch, although they notice it often enough. The Torrington Needle Bearing, "changed over" to production-for-war, is again demonstrating its efficiency—and adaptability—in applications where its unique advantages mean more today than ever.**

Its efficient system of lubrication, for example, which requires only occasional oiling, is reducing the need for maintenance attention or replacement. Its high capacity assures long bearing life, even in continuous operation under heavy loads.

Every feature of the Needle Bearing, significantly, is filling some important wartime need. Its small size is saving weight and critical materials; its remarkable ease of installation is cutting assembly time; its simplified design is eliminating extra parts and assembly steps, with low coefficient of friction assuring smooth performance.

When Victory may hang on the amount of time it takes to service fighting equipment, it is not surprising that maintenance men these days are finding Torrington Needle Bearings in more and more of America's war materiel.

***IF YOU HAVE A PROBLEM** which the Needle Bearing might solve, Torrington engineers can be of valuable assistance in adapting its advantages to your needs. You are welcome to their experience, as well as the information on Needle Bearing capacities and sizes in Catalog No. 114.*

**THE TORRINGTON COMPANY**
TORRINGTON, CONN., U. S. A. • *Established 1866*
*Makers of Needle and Ball Bearings*
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Cleveland · Seattle · Chicago · Los Angeles
San Francisco · Toronto · London, England

# TORRINGTON NEEDLE BEARING

*Every feature fills a wartime need*

# 10 Distinct Advantages OF REPUBLIC ELECTRUNITE AIRCRAFT TUBING

Because it is made from *flat-rolled* steel, cold-formed to tubular shape and then *electric resistance welded,* Republic ELECTRUNITE Aircraft Tubing offers ten distinct advantages—many of them not consistently obtainable by other processes.

1. **Uniform Diameter**
2. **Uniform Wall Thickness**
3. **Uniform Concentricity**
4. **Uniform Strength (*with a weld as strong as the wall*)**
5. **Uniform Weight**
6. **Uniform Ductility**
7. **Uniform Hardness**
8. **Uniform Weldability**
9. **Uniform Scale-Free Surface**

**The 10th advantage** is *uniform freedom from all injurious defects*—insured by test of every length by a specially-developed non-destructive electric method.

Republic ELECTRUNITE Aircraft Tubing meets specification standards of the U. S. Army Air Corps; Bureau of Aeronautics, U. S. Navy; and the Civil Aeronautics Administration.

It is made of S.A.E. X-4130 steel in sizes from ⅜″ O.D. to 1⅝″ O.D.—.028″ to .065″ wall; of S.A.E. 1025 steel in sizes from ⅜″ O.D. to 4″ O.D.—.028″ to .148″ wall; and of ENDURO* Stainless Steel in standard analyses in sizes from ⅜″ O.D. to 3″ O.D.—.028″ to .120″ wall.

Write for further information.

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*Republic*

# ELECTRUNITE

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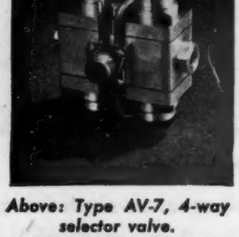
REPUBLIC STEEL — PRODUCTION FOR VICTORY

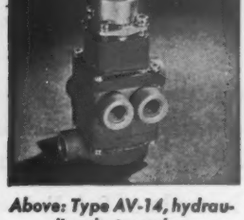
# SQUARELY
## MEETING THE NEED

**GENERAL CONTROLS AIRCRAFT TYPE VALVES DO IT *Electrically***

**SIMPLIFY** Save time, money, weight, space and man-hours as well as simplify installation and pilot supervisory operations with General Controls hi-g electromagnetic valves... General Controls 2, 3 and 4-way hydraulic valves handle up to 3000 lbs. or more, with flows from pilot flow to 16 g.p.m. or more... General Controls anti-icing valves are lowest in weight for use in simplified anti-icing control systems... General Controls gasoline valves are available up to 2" in size, with low head loss... General Controls valves for air and gases are also available up to 2" in size and for pressures to 3000 lbs., with high flows and low head loss ... Standard valves will meet requirements of most applications. For valves and special valve arrangements, write or wire our Engineering Department.



*Above: Type AV-7, 4-way selector valve.*



*Above: Type AV-14, hydraulic selector valve.*

*Above: Type AV-5, electric diaphragm valve.*

hi-g*

*TRADE MARK—hi-g indicates positive ability to operate in any position regardless of vibration, change of motion or acceleration.

*WRITE FOR ILLUSTRATED & DESCRIPTIVE BULLETIN*

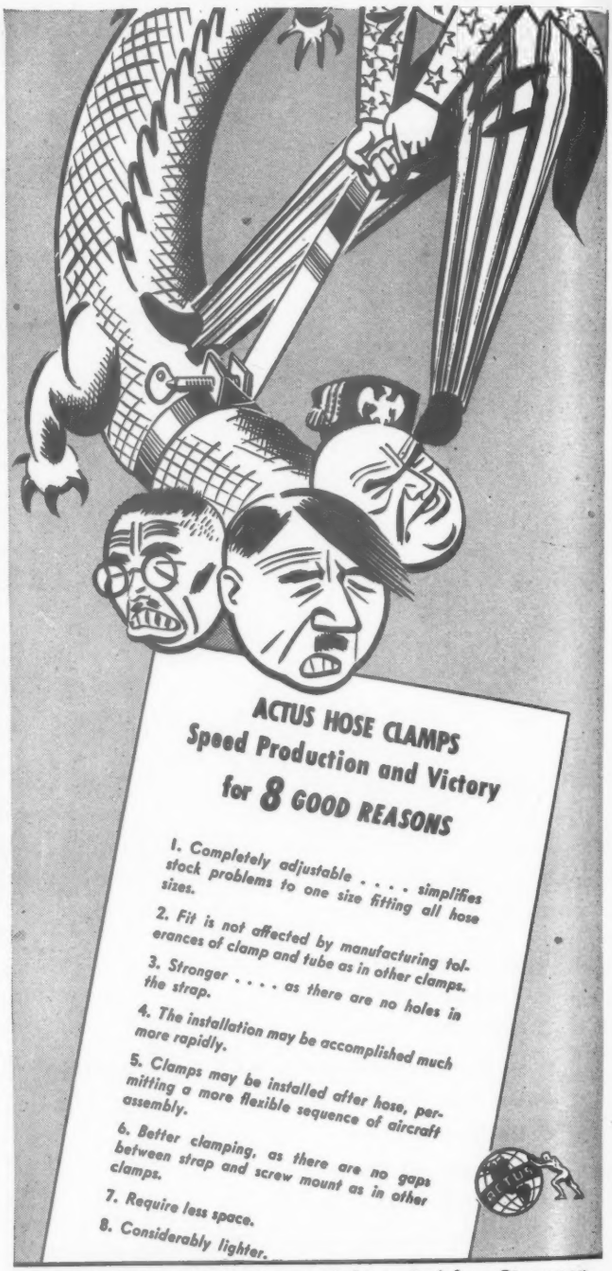
**GENERAL CONTROLS**

*PIONEERS AND LEADERS IN THE DEVELOPMENT AND MANUFACTURE OF MAGNETIC VALVES*

**801 ALLEN AVENUE, GLENDALE, CALIFORNIA**

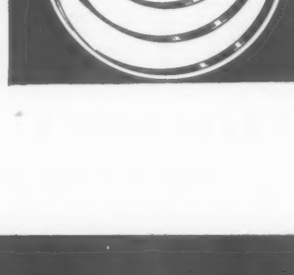
BOSTON • NEW YORK • PHILADELPHIA • DETROIT
CHICAGO • CLEVELAND • DALLAS • SAN FRANCISCO

# THROTTLING the Axis Monster!


ACTUS HOSE CLAMPS
Speed Production and Victory
for 8 GOOD REASONS
1. Completely adjustable . . . . simplifies stock problems to one size fitting all hose sizes.
2. Fit is not affected by manufacturing tolerances of clamp and tube as in other clamps.
3. Stronger . . . . as there are no holes in the strap.
4. The installation may be accomplished much more rapidly.
5. Clamps may be installed after hose, permitting a more flexible sequence of aircraft assembly.
6. Better clamping, as there are no gaps between strap and screw mount as in other clamps.
7. Require less space.
8. Considerably lighter.

**ACTUS HOSE CLAMPS are Lighter-Quicker-Stronger**

*Used by United States, Canada, Great Britain on Land, Sea and Air Fighting Equipment*




**ACTUS**
**PRODUCTS CORP.**
MOUNT VERNON,
NEW YORK

## Economics of Large-Scale Raids

With bombing raids getting larger and larger both in number of aircraft and bombs, the observer often questions the economics of the 1,000-plane raids, especially where losses in men and aircraft are concerned. The United States Air Forces so far have not made any raids which would compare with the 1,000-bomber excursions which the RAF has made to key points in Germany, and the following figures therefore are good only for the British methods of large-scale raids.

Current expenditures for the war in Britain are hitting $50,000,000 a day, and every 1,000-plus raid slices about $14,000,000 out of the budget. This amount is computed on the basis of a 5 percent plane loss—which adds up to $11,250,000—the cost of training the lost crews is figured at some $1,300,000 and bombs and gasoline used complete the item. The figures do not include pay to the returning crews, upkeep and repair of the aircraft and the payments to the members of the ground crew.

It is generally felt that a large bomber of the *Lancaster* class will cost about $300,000, while one of the lighter types will run around half that. Training of crews is costing the Empire around $4,000 per man, and the seven-man crew of a *Stirling* therefore represents an investment of $28,000, or $28,000,000 for the 1,000 planes of a large-scale raid.

Photographs made by RAF observation planes have indicated that this cost is well worth while, since damage to enemy territory, especially if long-term damage is figured out, generally runs many times the original outlay.

## Brazilian Treasure Hunt

Out of Brazil comes a story of the successful treasure hunt for an American bomber forced down in the jungle 80 mi. south of the Amazon estuary. The airplane made a miraculous forced landing in a small clearing in July, and came down completely undamaged. By air the location was about 20 min. from Belem, but it took the crew some eleven days of hard work to get there through the steaming tangle of trees. With the cooperation of the Brazilian Air Force, Pan American Airways' employees managed to relocate the airplane, find the exact course from their camp to the plane and arrive four days later in the small clearing. A few days later a full-scale recovery crew set out for the plane, and started work on Aug. 10 to clear a takeoff strip. With some 54 natives and an additional 50 men sent from Belem, fed with fresh food dropped every other day from an airplane, a runway was cleared and completed by Sept. 3. Only casualty in the adventure was M. de la Torre of Panam who picked up malaria.

## New Nazi Army Cooperation Plane

Appearing on the Eastern front for the first time is the Henschel 129, a low wing twin-engine bomber designed for both anti-tank attacks and low-level bombing and strafing raids. The plane, heavily armored around the cockpit, has a 30 mm. cannon and two heavy machine guns for anti-tank work, or two 20 mm. cannon and two lighter machine guns for bombing raids, when a 750-lb. bomb can be carried. Notwithstanding a complete absence of armor around the vital structural parts of the plane and engines, the topspeed is only 275 mph., and experience has indicated that this type of plane can only operate with reasonable success when covered by large numbers of pursuits and fighters.

## Postwar Plans

Postwar aircraft provides a subject for discussion when British engineers find time for it. More and more interest is shown in cargo planes, and it is said that 5,000 craft of a size now being built could bring nearly 1,000,000 men to Britain in 15 hr, or move 150,000 tons each way in one week. For regular services a Commonwealth Board of Merchant Air Services has been suggested, which would include the chiefs of air service departments of the participating nations, with international arrangement of rates, schedules, ground facilities, etc. The scheme provides for virtual "freedom of the air," each member-nation being allowed full reciprocal rights in all the other member countries.

*Press Association, Inc.*

**SOVIET "X" FACTORY HUMS**

Scores of "Yak" fighters on Soviet "X" factory assembly line. Despite Nazi smashes at Stalingrad and in the Caucasus, Russia is reported to have produced more warplanes in October than in September, bettering quotas.

## New de Havilland Development

Latest in the long series of extremely successful aircooled engines built by de Havilland is the *Gipsyqueen* IV, a six-cylinder inverted supercharged aircooled engine. Designed mainly to give better performance in planes mounting older types, and to give training pilots more experience with the complicated controls of a supercharged engine, the *Gipsyqueen* IV, together with the IIIS type variation, gives 300 hp. for takeoff and 180 hp. for cruising at an altitude of 12,000 ft.

Rather remarkable is the fact that these engines are all equipped with a Hamilton Standard license constant speed propeller also built for de Havilland. These propellers are built for engines from 200 hp. up, and variable pitch props are even available for engines of 140 hp. The *Gipsyqueen* IV is now being fitted into the Airspeed *Oxford* IV, which is in large-scale use as a general utility plane in England.

## Canadian News

**BY JAMES MONTAGNES**

It is now possible to state that the secret two-engine fighter being built by de Havilland Aircraft of Canada is the new British *Mosquito* bomber-fighter. Full production of these planes is now under way. The plane is largely constructed of wood, due to a bottleneck in light metal materials. Another wooden or partly wooden plane being built in Canada is a new version of the Avro *Anson*, used in training of bomber pilots and navigators. The aircraft is made of molded plywood, powered with Pratt & Whitney 450-hp. engines. The new model differs from the previous Canadian-built and English *Ansons* in that it has a completely redesigned molded plywood fuselage. The plastic fuselages are being made in western Ontario, and the complete plane will be built under the shadow system controlled by the government-owned Federal Aircraft Ltd. Improvement in the *Anson* is part of an integrated plan to revise British Commonwealth Air Training by placing emphasis on the nagivator as the su-

preme member of the crew of a modern heavy bomber.

**An exhibit showing** how wartime Canadian industry is meeting a shortage of critical materials, manpower and machinery by new methods of manufacture was held at Toronto recently under the auspices of the Department of Munitions and Supply for war plant executives. Among new production methods exhibited by aircraft manufacturers were a number of methods of molded plywood uses. The rear seat of a de Havilland *Tiger Moth* elementary trainer was formerly made of welded aluminum sheets. Now birch plywood, glued with casein, is being used, making for an annual saving of 5,412 lb. of aluminum. Plywood wing tips for North American *Harvard* advanced trainers are being used to replace tips made of formed and riveted aluminum ribs and sheets. Nose reinforcements for *Harvard* trainers are being made of birch veneers, which are molded into shape in steam pressure tanks.

**One of the most** spectacular exhibits showing how large sums of money could be saved by seemingly unimportant details was that which showed annual savings of $7,000 in painting rondels on aircraft wings. By stenciling them on, the method is reduced from six operations to one, and money and time are conserved. Federal Aircraft Ltd., government-owned company, showed its annual savings in the new method of applying rondels to aircraft as 35,712 lb. of material, 11,160 hours of labor, worth together $25,668. Manpower and materials saved by this and other new production shortcuts and material savings in 1941 by this company were sufficient to build eleven *Bolingbroke* bombers. Life of airplane tires can be prolonged greatly by retreading the tires with only 14 percent of the crude rubber content of the original tire, rubber experts stated.

**Important changes** in the operations personnel of Trans-Canada Air Lines have been announced. Capt. B. A. Rawson, former assistant operations superintendent at Toronto, has been named superintendent of flight operations, and will maintain his offices in Winnipeg, and Capt. Frank Young, who was formerly captain in the regular flying service out of Toronto, has been promoted to the position of chief pilot.

N. J. Humphreys has been moved from the post of despatcher at Lethbridge, Alta., to chief despatcher with office at Toronto.

## Beauforts Go Into Action

While it has been known for some time that Australian airplane plants were in large-scale production of the new *Beaufort* torpedo bomber, there had been no indications until very recently that these planes had been used in actual attacks upon the enemy. According to the Australian Air Minister, Arthur Drakeford, the planes had been used for some time in observation and light bombing flights along the Australian coasts, and had operated with marked success against submarines. However, a full-scale torpedo attack was made against Jap ships during September with excellent results, so that further forays of this type can be expected in the future.

## New Type Cannon Shell

Reports from Moscow indicate that the Germans may be using a new type of cannon shell in their Me-109G's which enables them to open fire at 300 to 500 yd. The main reason for this innovation appears to be the loss of penetrating power of cannon shells at greater distances, which causes the instantaneous fuse to explode the shell before sufficient penetration is available for maximum damage. At the same time the fuse mechanism seems to be a little too delicate on the small calibre cannon (under 37 mm.), and good use of this development comes only in the larger type cannon such as are now used on our *Airacobras*.

## Further British Conversions

Instead of sending their obsolete aircraft to the scrapheap, the British are using them to train their future pilots, tote cargo the world over and torpedo Axis ships in their home waters. Latest in the series is the announcement that the *Hampden* medium bombers have been converted to torpedo planes for the Coastal Command, where their 270-mi. speed and 2,000-mi. range prove extremely useful for the extended patrolling which is now undertaken.

## Eire Airline Expands

The Aer Lingus Teoranta, the Irish aviation company, has opened its first internal airline between Dublin and Limerick. The line may be extended to Cork later on. One of its purposes is to provide a more efficient link with the transatlantic services of Pan American and American Export.

## ON SCHEDULE . . . by "Vista"

**For about seven months** the Swedish ABA airline, operating in the face of mounting difficulties, has maintained a night mail service non-stop from Stockholm to Great Britain. At present this line is being operated on a weekly schedule with Junkers 52's, of which the ABA has quite a few, and it is quite remarkable that this service can be maintained over this notoriously bad stretch of territory. It is hoped that eventually the line will be developed into a major passenger route, eliminating the long detour via Holland and Germany which was maintained before 1940.

**The word "finis"** has been written very effectively across the record of the Italian LATI, notorious spyline which once flew from Brazil to Italy, by Foreign Minister Aranha of Brazil. The State officially took over six large flying boats which LATI had laid up in Rio de Janeiro, and started operations on a new line up the Amazon to rubber plantations which are now being developed. It is rather strange and also pleasing that these planes, which once smuggled money, information and vital war materials across the Atlantic, are now doing their bit to add to our war effort.

**Prospects for British Overseas Airways,** now beginning to feel the pinch of all out warplane production and normal plane losses, were a little brighter last month. During a discussion in the House of Commons the Secretary of State for Air was asked whether some action was contemplated to increase the number of modern aircraft now available to British Overseas Airways' operations. Sir Archibald Sinclair, long a champion for England's air routes, informed the House in general that such action had already been taken. From all appearances therefore BOAC will soon be able to replace its outmoded and aged planes with something a little faster and safer, which in turn should do the farflung operations a lot of good.

## Canadian Civilian Flying Schools

The No. 9 Air Observer School at St. Johns, P. Q., is a typical college of the air, where students undergo intensive and highly technical instruction in a concentrated space of time. Operated by Dominion Skyways (Observers) Ltd., under the supervision of Canadian Pacific Air Lines Ltd., this school forms part of the Empire Air Training Program which must supply the manpower for the coming offensive.

The RCAF part of the show is directed by a ranking air officer known as the chief supervisory officer. The RCAF supplies all the ground instruction and gives the trainees all their theoretical training in the lecture rooms. The Air Force is also responsible for their discipline and administration.

The civilian share in the work of operating the school is controlled by a general manager, and an executive staff. In many instances at Canadian Pacific Air Lines' schools, the executive civilian officers are veterans of World War I, who were members of the old Royal Flying Corps. And their job is a big one—and varied.

Here is what the civilian company must attend to:

1. Supply all the civilian pilots for flying the air navigators on exercises. Most pilots come from Canada and the U. S., or are Sergeant Pilots on leave, and have to be specially trained for this kind of work.

2. Be responsible for the maintenance of all aircraft, supply all radio installations and communications with their operators and upkeep.

3. Supply all catering at the camp.

4. Be responsible for operation and maintenance of all quarters and grounds.

5. Provide all equipment to keep the school going summer and winter.

6. Maintain all necessary safeguards, such as fire-fighters, watchmen, etc.

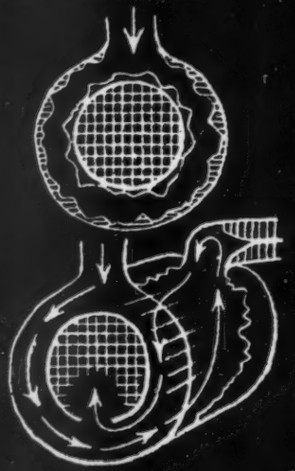
7. Be responsible for all heating, fuel, transport, stores, and whatever else is needed for the operation of the school. The present camp has about 300 civilian employees, but its size is being doubled, and when expansion is completed the number of planes, instructors and output of trained navigators will be trebled as Canada continues to supply more and more skilled airmen to the United Nations.

*First enemy met on icy mornings...*

# SURGE PRESSURE

**CAUSE:** Oil thickened by freezing temperatures creates excessive pressure on congealed oil cooler when engine starts.

**RELIEF** Standard-type pressure relief valve by-passes oil cooler core—but does not protect cooler against possible back-pressure from congealed oil lines!



**CURE:** A NEW-AND PROVEN-DESIGN FOR "SURGE PROTECTION"

## AiResearch Oil Cooling Systems now provide *full, automatic* "Surge-Protection"

UP TO NOW, the surge of cold, thick oil has constantly threatened the oil system during engine starting in sub-zero weather. By-passing has helped some. But unless pressure great enough to clear the congealed oil lines is directed around the oil cooler, surge pressure will back into the oil cooler—collapse the core tubes.

AiResearch mustered its specialized "know how" to lick this problem. The answer developed by our engineers has recently been flight-tested. Complete, automatic "surge-protection" is now an accomplished fact!

AiResearch's "surge-protection" is assured by a pressure sensitive element that *measures* the oil pressure and then *directs* the flow of oil accordingly to safety requirements.

If pressure is excessive, it provides *complete* by-pass through *sealing* the entrance to the oil cooler—protecting it against excessive back pressure. It maintains *safe* pressure in the cooler itself to insure fast thaw-out... helps build and maintain full pressure necessary to clear oil lines. And it increases engine safety by assuring proper oil "conditioning" in a minimum amount of time.

Fully automatic, this new "surge-protection" for AiResearch Oil Coolers is now in volume production. Manufacturers, interested in the safety advantages it offers their aircraft, may write or wire for full details.

AiResearch
MANUFACTURING COMPANY
LOS ANGELES, CALIFORNIA
DIVISION OF THE GARRETT CORPORATION

*"Where Controlled Air Does The Job"* • Engine Coolant Systems • Automatic Exit Flap Control Systems • Supercharger Aftercooling Systems • Engine Air Intercoolers

# WINGS FOR THE CHINA DRAGON

There is new pride in the flight of our symbolic Thunderbird...a pride born with our exclusive appointment to give Chinese Air Force cadets their all-important primary training...a pride shared by every Southwest Airways employee.

It is a responsibility, too—one that we have not...and shall not, bear lightly. Throughout our growth in Arizona's Valley of the Sun to one of the Nation's *largest* primary schools, we have worked constantly with the Army Air Force to develop safer, more efficient training. When Victory is won, these skills will be turned again to peacetime tasks.

But today, our job is clear. We are giving wings to the American Eagle—*and now the dragon shall fly!*

## SOUTHWEST AIRWAYS

*Phoenix, Arizona*

THUNDERBIRD FIELD • FALCON FIELD • SKY HARBOR • THUNDERBIRD II

TRAINING THE FINEST FIGHTERS TODAY, THE FINEST FLYERS TOMORROW

CONTRACTORS TO THE UNITED STATES GOVERNMENT • UNITED STATES ARMY • UNITED KINGDOM GOVERNMENT

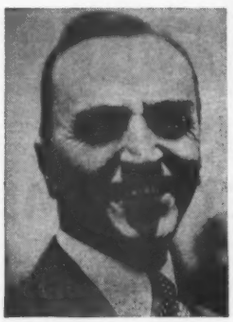
NORRIS DEAN JACKSON has been appointed director of labor relations for NWA, a newly created office. Mr. Jackson has been assistant state labor conciliator in Minnesota since 1939; before that was a special conciliator, and member of Minnesota's fact-finding committee. ERNEST W. YORIS, former Seattle police official, was appointed director of internal security. He will have complete charge of all guard and police activities for the system, and will visit cities all along the system to discuss with local authorities the question of security and plant protection.

SELIG ALTSCHUL, financial editor of "Aviation," and second place award winner of TWA's writer's contest, was appointed to the Research and Analysis Division of Civil Aeronautics Board. He will be head analyst of the division and will study air transport problems.

ROBERT D. SPENCER, aeronautical engineer, has joined General Tire as manager of aeronautical sales and engineering, where he will direct all aviation tire design and contact the country's aviation companies as aeronautical sales director. He has been in aviation since 1935.

A. E. SHELTON, formerly works manager of the Stinson Division of Vultee, has been promoted to the newly created position of division manager. Before joining Vultee in February of this year, Mr. Shelton was president and general manager of Menasco, and before that pur. agent of Lockheed.

WILLIAM F. McGRATH, veteran transportation executive and present Eastern regional manager of TWA, was elected president of the Air Lines Terminal Corporation at the stockholders' annual meeting. Formerly in the steamship industry, he joined TWA about two years ago as Eastern traffic manager.



CAPT. E. V. RICKENBACKER, proud owner of a charmed life. After drifting in the Pacific for 24 days he was picked up by a plane so small he had to be lashed to the wing and taxied 40 mi. to a South Pacific base. He is resting before starting out again to complete his mission. All of his party are accounted for.

JEWEL "SKIPPER" STANTON has been appointed primary flight commander in the civilian flying school at Spartan where she will be in charge of the coordination of students, instructors and airplanes in the primary training unit, and as a check pilot she will give flight checks to the students and instructors.

*U. S. Navy*

REAR ADMIRAL PATRICK N. BELLINGER, one of three temporary rear admirals nominated by President Roosevelt to be permanent rear admirals. Admiral Bellinger is a naval aviator who distinguished himself as commanding officer of the seaplane NC-1 on an overseas flight from Newfoundland to the Azores.

EDWARD G. BERN, has been appointed sales manager for Hughes Aircraft. He is a veteran of World War I and on his return from France he organized and was the first president of Kansas City-Wichita Airways, one of the first airlines established in the U. S. He was pres. of Columbia and regional v. p. of AAL.

*Ben Pinchot*

I. S. RANDALL, assistant to the chairman of the board of TWA, takes over the post of gen. mgr. of the Aircraft War Production Council for East Coast airframe manufacturers. His new post will include coordinating aircraft mfrs' information among members of the East Coast Council.

C. P. SHROPSHIRE, who for the past two years has been traffic manager of Vultee's Inland Division, has taken up new duties in Washington, where he will serve as director of traffic and transportation for the AAF, as the result of a request by Lt. Gen. Arnold.

*U. S. Air Corp.*

LIEUT. GEN. GEORGE C. KENNEY, holder of the D. S. C. and Silver Star, was nominated to the temporary grade of lt. gen. by Pres. Roosevelt. He served as Chief, Prod. Eng. Section, Wright Field, until 1941; was assigned command of the Allied Forces in the Southwest Pacific.

ASSEN JORDANOFF, flyer and author, has formed the Jordanoff Aviation Company, and GEORGE F. McLAUGHLIN, former editor of "Aero Digest," has been named director of production. The new organization will prepare illustrated technical aviation manuals to be used in instruction in aircraft flight and maintenance and will be furnished the government air services as well as private enterprises.

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*is the Hall-mark*

OF

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## INDUSTRIAL AIR LINE EQUIPMENT

For the past quarter of a century Hansen air line equipment has been the outstanding *quality* line, never built down to meet a price but always maintained at a high quality level.

Hansen *quality* means more than just a talking point, it means advanced engineering, hair line accuracy, skilled craftsmanship and the finest materials obtainable. Hansen superiority is brought out and demonstrated in greater performance, speed, ease of operation, extremely low maintenance cost and longer life. Thousands of large and small industrial plants throughout the world are completely Hansen equipped.

Hansen—a name which means the finest in modern air line equipment that more than meets the demands of today's production and tomorrow's competition. *Send for free catalog.*

HOSE CLAMPS • AIR HOSE COUPLINGS
HOSE CLAMP SOCKETS • HOSE CLAMP PLUGS
AIR LIQUID SPRAY GUNS • ENGINE CLEANERS
AIR BLOW GUNS • SAND BLAST CLEANERS

**Hansen MFG. CO.**

INDUSTRIAL *Air Line* EQUIPMENT

1786 EAST 27TH STREET . . . . CLEVELAND, OHIO

**The first large Regulation V loans** for the aircraft industry to reach the New York capital market have been arranged by Lockheed Aircraft Corp. and its subsidiary, Vega Aircraft Co. The Lockheed loan of $60,000,000 will be managed by Bankers Trust Co. while the $30,000,000 Vega credit will be handled by the Central Hanover Bank & Trust Co.

**Preparations** for a $200,000,000 loan of the same type for Bendix Aircraft Corp. are being completed and the loan will be managed by a Midwestern bank. Briefly, the V-type loan provides for a government guarantee up to 90 percent of the amounts borrowed and they are self liquidating upon completion of deliveries under war contracts.

**Large banking groups,** ranging from a dozen to several hundred institutions, join together to make the funds available as the amounts are so large they would be unable to handle them individually under the banking laws. Amounts that can be loaned to any one customer are strictly limited under the law. In some cases the aircraft industry has financed war contracts directly through the government without participation by the banks. The V loans, however, permit more flexible financing arrangements. Corporate receipts and disbursements, for example, need not be segregated as these new loans apply to a company's total war contracts.

**United Aircraft's third quarter report** provides one of the few straws on the subject of 1942 earnings of aircraft companies as nearly all other concerns come under the Army's interim report ban. United earned $10,415,920 or $3.55 a share for the first nine months, compared with $10,771,730 or $4.05 a common share in like 1941 period. However, in the 1941 period United set aside a special $4,000,000 postwar reserve. The dollar volume of shipments for the nine months was about 80 percent larger than a year ago, yet earnings showed a moderate decline due to the lower prices now obtaining in war products delivered to the United States government. Total tax reserves were slightly lower than last year due to the new revenue act provision limiting tax levies to 80% of taxable income.

**United Aircraft has moved** into the billion-dollar class, a distinction that was held by Curtiss-Wright alone in the aircraft group when most major companies discontinued issuing unfilled order reports after Pearl Harbor. United's backlog of orders totaled $1,232,319,534 on Sept. 30, compared with $914,191,113 on June 30, and $499,048,847 the previous year. Just short of half a billion dollars in orders was booked during the third quarter.

**Stockholders of aircraft companies** are getting their year's dividend payments in one sweep. Among the recent declarations are: Douglas Aircraft, $5 a common share; Bell Aircraft, $2 a share; Liberty Aircraft Products, 25c. a share; Lockheed, $2 a share, and North American Aviation, $1 a share. Bell, Douglas and Lockheed made the same payments in 1941 while North American dispersed $1.25 a share last year. Fairchild Aircraft Ltd. of Canada declared an initial dividend of 25c. a share last month, while Timm Aircraft Co. made a 5c. payment on each capital share. A similar dividend was paid last July.

**Aggregate market value** of aviation stocks listed on the New York Stock Exchange in October totaled $601,827,000 or an average price of $17.41 a share. Aviation stocks stood twelfth in aggregate value out of 25 leading industrial groups.

**Thompson Product's investment** in Thompson Aircraft Products Co., a subsidiary, amounted to $905,000 at the close of September. The subsidiary operated at a deficit of $345,000 in 1941 when production was just getting under way but is now operating profitably. Combined sales of the parent company in the first nine months were $61,753,000, of which the aircraft subsidiary accounted for $18,666,000. Earnings for the same period were $1,463,900 or $4.61 a share against $1,264,700 or $3.92 a share in the like 1941 nine months. Thompson Aircraft Products contributed $495,000 to the 1942 earnings total. Sales for the year are expected to approximate $90,000,000 compared with 1941 shipments of $42,459,000.

**Continental Motors Corp.** is negotiating with banks for a large line of credit to finance its expanding business, according to reports. On Oct. 31 the company completed by far the greatest sales year in its entire 40-years history.

**National Aviation Corp.,** an investment trust, reported two changes in its investment portfolio between June 30 and Sept. 30. A total of 2,500 shares of Glenn L. Martin Co. stock were sold, bringing the holdings of that issue down to 7,400 shares. Also 1,200 shares of Pan American Airways were liquidated, leaving 12,400 shares still held.

**Completing its third fiscal year** on July 31, Northrop Aircraft expanded sales to $32,983,000 compared with $3,407,000 in the preceding fiscal year while operations showed a profit of $3,044,741 compared with a deficit of $848,779 in 1941. The annual report revealed that a $17,000,000 V loan was obtained in August from a group of banks headed by the Chase National Bank. Objects of the company were listed as: (1) To use profits to increase facilities to their maximum efficiency, (2) to build up working capital, and (3) to establish a sound dividend policy. The report stated that the first object had been achieved and the second is on the way but the third will depend for the duration largely upon the tax laws.

**The Aviation Corp.** reported net earnings of $3,671,716 or 64c. a share for the nine months ended Aug. 31, compared with $1,459,649 or 25c. a share in the like 1941 period. At the same time sales were $29,635,200 against $11,727,780 a year ago. These earnings do not include the company's share in the undistributed profits of its numerous subsidiaries, such as Vultee Aircraft and New York Shipbuilding Co.

**Braniff Airways** is now doing more passenger business with 7 airplanes than it did last

★ ★ ★ By RAYMOND HOADLEY ★ ★ ★

DIVIDEND PAYMENTS by aircraft companies in the first nine months of 1942 showed a decline of no less than 45 percent under the like 1941 period—a heavier decrease than that reported by any other group. Aircraft stockholders began to hold their hats in anticipation of a bumpy ride as even the converting automobile industry had curtailed dividends only 35 per cent. But in October Congress finally passed this year's revenue act and the industry was able to figure more intelligently on its probable profits for 1942. As a result, dividend payments declared late in October amounted to $9,746,753 or about one-third more than the $6,712,000 disbursements made in the entire first nine months among the 19 major aircraft concerns.

October payments, it might also be noted, were the second largest for any past month while November announcements were expected to bring the total for the year above the 1941 finals. Some companies may not pay out quite as much as last year but, on the other hand, a number of companies, such as Beech and Vultee, initiated dividends and Boeing resumed payments after a five-year lapse.

The first war tax measure is much more lenient toward business than had been expected. Hence, the improved outlook for aircraft earnings and dividends. The Administration had asked a corporate tax rate of 55 percent and a 90 percent excess profits tax. Congress approved a normal tax rate of 45 percent and the 90 percent excess profits tax. But the legislators went further. A postwar credit of 10 percent on excess profits taxes was voted and companies are allowed to take 40 percent of their debt repayments as a deduction from this tax and as an offset against the postwar credit.

From the standpoint of aircraft companies the best thing about the new law is the 80 percent tax ceiling. Most aircraft companies will have extremely high excess profits in relation to either capital or past earnings. Jumping, as they have, from relatively small peacetime operations to the nation's largest war industry, such a tax ceiling was vitally needed to enable them to finance their working capital needs and still pay out something to patient stockholders. Without this tax limit some companies would have had to pay more than 90c. out of every earnings dollar to the tax collector.

Another helpful provision in the act is designed to aid companies that happened to have an abnormally poor year during the 1936-1939 base period for the average earnings exemption for excess profits. Now a company is allowed to substitute 75 percent of the average of the other three better years in figuring its exemption. Several aircraft companies probably will take advantage of this choice.

★ ★ ★ ★ ★

*Winging to Victory!*

**WITH "40-E" SCOTT-CAST ALUMINUM-ALLOY CASTINGS**

From "grasshoppers" to multi-engined bombers, Scott 40-E castings are playing a prominent role in the production of "Wings for Victory." Selected by Scott engineers for use in Scott accessories requiring exacting physical properties, Scott 40-E castings are now answering many engineering and design problems in general aircraft construction.

40-E castings are exceptionally high in ultimate strength, yield strength and pressure-tightness. Not heat treated, these castings attain ultimate strength in 21 days by room-temperature ageing; and, if urgently needed, can be machined five days after casting. Ageing normally takes place during assembly or fabrication.

Due to high yield strength, Scott 40-E castings readily replace most standard heat-treated alloys. They are easily welded and can be furnace-brazed to aluminum brazing sheet. Periodic checking by x-ray assures uniform quality of grain structure.

Production of 40-E is now approaching maximum capacity—yet Scott facilities still permit the meeting of a few additional demands. And, in accordance with Scott policy, *all orders accepted will be delivered on schedule.*

**CONSERVATIVE PHYSICAL CHARACTERISTICS OF "40-E"**

| TENSILE | | YIELD STRENGTH | | ELONGATION | |
|---|---|---|---|---|---|
| TYPICAL | MINIMUM | TYPICAL | MINIMUM | TYPICAL | MINIMUM |
| 33,000 | 29,000 | 24,000 | 20,000 | 6% | 4.5% |

(In pounds per square inch)

**SPECIFICATIONS**

U. S. Navy 46-A1-Class 1 A. S. T. M. — U. S. Army Air Force 11-324 B-26-37-T.

Scott AVIATION CORPORATION
LANCASTER, N. Y., U. S. A.
DESIGNERS AND MANUFACTURERS OF SPECIAL EQUIPMENT FOR THE AIRCRAFT INDUSTRY

SUPPLIERS TO THE U. S. ARMY AND NAVY AIR FORCES AND LEADING AIRCRAFT MANUFACTURERS

year with 16 planes. At last report income from passenger traffic also is running slightly in excess of last year.

**Airlines generally** are reporting decreases in passenger traffic on their regular runs due to the transfer of equipment for military operations. At the same time air mail volume is at new record peaks and express is running from 150 to nearly 200 percent ahead of last year in several cases.

In two instances domestic airlines are reported to be operating at least one and sometimes more of their regular daily schedules as straight cargo carriers.

## ON THE RAW MATERIALS FRONT

NO LONGER will millions of American boys be able to secure balsa wood for their model airplanes. In fact, the aircraft industry itself is finding difficulty in obtaining this wood as a substitute for light metals in plane production. Donald Nelson has decreed that for the time being all new supplies of this amazingly light wood must be sent to Great Britain to aid there in giving the Allies mastery of the air over the Channel. The British are reported using large amounts of this special wood in their new de Havilland *Mosquito* bomber.

From the West Indies to Bolivia, and especially in Equador, battalions of lumberjacks, directed by United States lumber experts, hack through the tangled forests on the Equator for this vital material. No wonder balsa is in such great demand by the United States, Great Britain, Australia and Canada. It is only one-half as heavy as cork and is stronger than spruce. Furthermore it grows fast, shooting up 50 ft. in five years, and then is ready to be cut. The United States does all the buying for the United Nations and every effort is being made to step up the supply. The recent shipment of a huge drying kiln to Equador, for example, is expected to add 2,000,000 b.ft. to the 1943 supply.

But balsa is not the only wood in limited supply. Lumber generally is becoming as scarce as some of the metals. Production is going down and requirements are going up. War production officials estimate that consumption needs for 1942 at 38,000,000,000 b.ft., made up of 32,000,000,000 b.ft. of softwoods and 6,000,000,000 of hardwoods. In 1943 the situation will change but little, with some needs dropping but other military requirements increasing.

Against these estimated consumption figures we had a production in 1941 of 30,000,000,000 ft. of softwoods and 6,000,000,000 ft. of hardwoods. Output this year is estimated at anywhere from 10 percent to 85 percent under 1941. As a result, WPB officials say that even if the current downward trend in lumber production is halted, we still will be short some 5,000,000,000 ft. in softwoods and 750,000,000 ft. in hardwoods in 1943.

The volume of dimensional lumber of fine quality needed for the aircraft construction programs of the United States and the lend-lease governments at the present time and for the next year exceed the present production rate by about two times, according to Arthur Upson, lumber chief in the WPB. In other words, the optimum program of the United Nations calls for twice as much Sitka Spruce, Noble Fir, West Coast Hemlock, Douglas Fir and Yellow Poplar as can be produced under present conditions.

The hardwood veneer and plywood situation is not now serious but it might become so almost over night. The Higgins and Kaiser cargo plane programs, for instance, will eventually call for huge quantities of plywood. Right now the capacity of the hardwood plywood industry, with its present equipment, is estimated at 180,000,000 sq.ft. a year on a 3/32 in. basis. The industry has a large amount of special machinery on order, all of which should be received by next April. That would increase its capacity to 300,000,000 sq.ft. annually. Not all the present plywood plant capacity is currently being used for plane parts and other war implements, so the bottlenecks that may appear here are more apt to be labor and the difficulty of getting good quality timber for the necessary veneer rather than plant capacity. There is a shortage in tough ash used for plane parts and handles.

The substitution of wood for metals now exceeds 6,000,000,000 b.ft. and has saved 2,500,000 tons of aluminum, steel and copper besides 200,000 tons of rubber. The aircraft programs of the United States and the United Kingdom will require huge amounts of birch, yellow poplar and red gum veneer for plywoods and certain softwoods. Just how much is, of course, a military secret. But it will be sufficient to necessitate the allocation of high quality logs in these three species solely for aircraft manufacture.

# Happy Landings

## FOR GLIDER-BORNE TROOPS

The giant Commando gliders—newest "cogs" in our air forces' Victory machine—are effectively equipped with Scott Tail Wheel Assemblies, to facilitate easier ground-handling—more ground maneuverability.

Developed by Scott specifically for glider installation, these special assemblies are patterned after the standard Scott Full Swivel design. Exceptionally light in weight, rugged and shock-resistant, these glider units are marked by an unusual production advantage: *no strategic war material is employed in their construction.* Even the tires are a special molded, composition in place of rubber!

## SCOTT *Full-Swivel* TAIL WHEEL ASSEMBLIES

And as another contribution to Victory joins the growing Scott family of air craft accessories and special equipment which now includes Oxygen Manifolds...Oxygen Regulators...Brake Pressure Units...Control Wheels ...Stabilizer Yokes...Rudder Horns...Aileron Bell Cranks and 40-E *Scott-Cast* Aluminum Alloy Castings.

Your inquiry on special equipment problems answered promptly and in strict confidence.

Scott Aviation flies the Army-Navy "E" Flag for production achievement.

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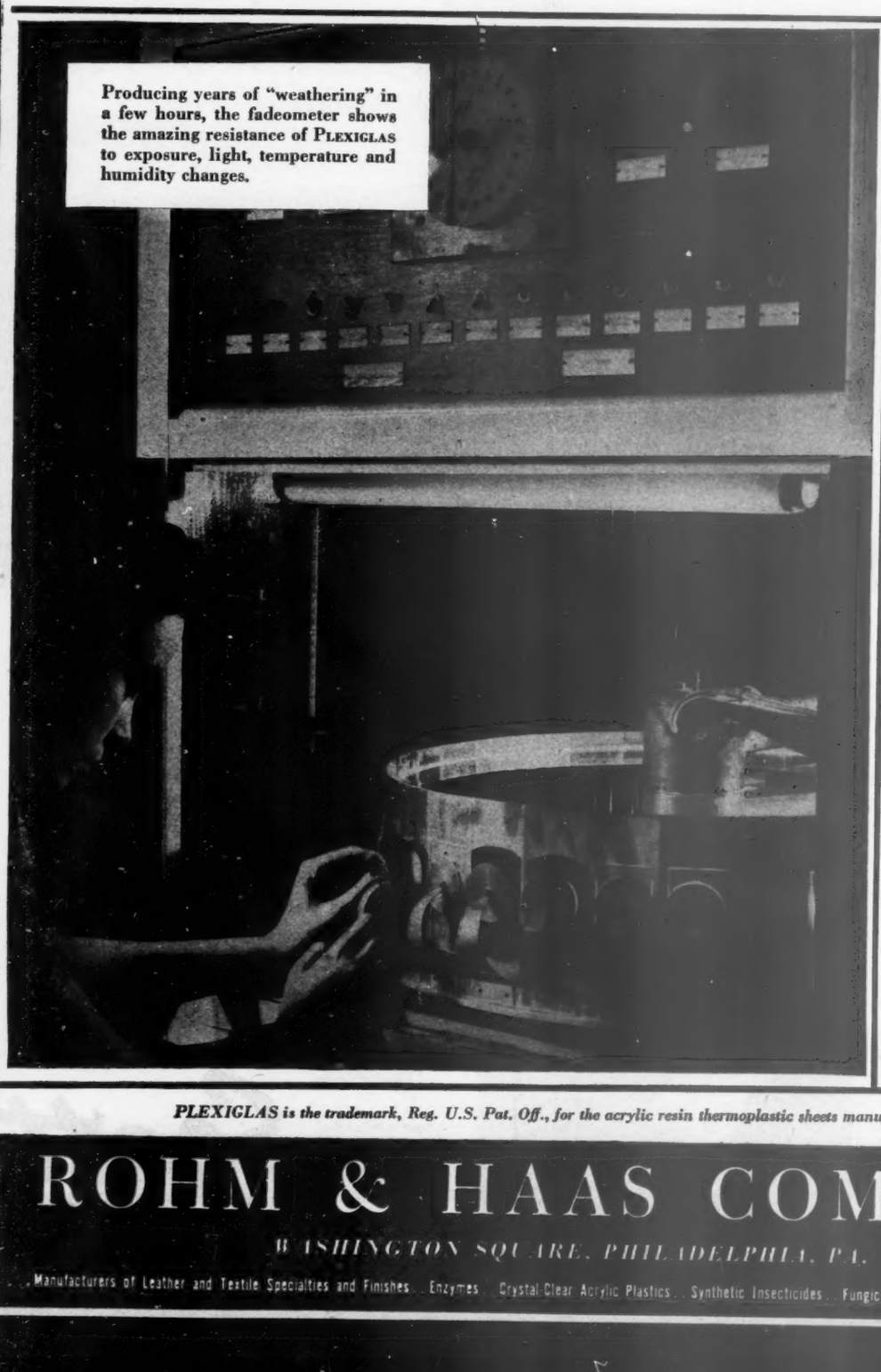
# *Useful data on*

# PLEXIGLAS

## OPTICAL PROPERTIES



**Producing years of "weathering" in a few hours, the fadeometer shows the amazing resistance of PLEXIGLAS to exposure, light, temperature and humidity changes.**

EXCEPTIONAL resistance to accelerated aging is just one of the many valuable properties of PLEXIGLAS described in a technical booklet published recently by Rohm & Haas. This booklet, entitled *PLEXIGLAS Optical Properties,* also contains complete data on PLEXIGLAS index of refraction, dispersion, transmission, X-ray transmission and optical density. Engineers, designers, and physicists will appreciate particularly the unusually large number of photographs, diagrams and charts contained in *PLEXIGLAS Optical Properties.* Write for your copy of this valuable reference booklet.

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**PLEXIGLAS**

SHEETS AND RODS

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**CRYSTALITE**

MOLDING POWDER

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# Recent Books

**QUEEN OF THE FLAT-TOPS,** *by Stanley Johnston. Published by E. P. Dutton & Company, New York. Illustrated, 280 pages, $3.00.*

A vivid, first-person account of the last cruise of the aircraft carrier *Lexington* rewritten from his newspaper dispatches by the only reporter aboard.

His story is occasionally padded with interesting trivia such as the ceremony on crossing the Equator, how the Navy bakes bread, and adventures of pilots downed on Pacific islands, but the reconstructions of major actions are succinctly dramatic, devoid of weepy heroics.

During her last three months afloat, planes from the Lady (as her crew often called her) wiped out a Jap fleet at Tulagi and assisted in knocking down scores of planes and sinking two carriers. Then the Japs found her. In 16 min. 103 planes assaulted her with bullets and five torpedoes which started fatal fires.

With brief anecdotes Johnston recreates the nonchalance of the officers and crew during the last few hours. About 5 o'clock on June 8—six hours after the first torpedo hit—Adm. Fitch gave this simple abandon order to Capt. Sherman: "Well, Ted, let's get the men off." Sherman believes that all aboard were saved. Most of the men went overside casually. One mechanic even waited to report to Comdr. Hamilton that a new wobble pump had been installed in his plane. "Took you a long time," Hamilton jested.

"Yes, sir. I had to draw one from the store and had an awful time to get to it. There's a terrible big fire down there."

To Johnston "in the deepening twilight it was a sight of awful majesty, one that wrung the hearts of all who watched."

**PLASTICS FOR INDUSTRIAL USE,** *by John Sasso. Published by McGraw-Hill Book Company, New York. 229 pages, illustrations, appendix, and index, $2.50.*

A guide and idea stimulus for new uses of plastics by a frequent contributor to AVIATION. Following a general discussion of designing, molding and machining, Mr. Sasso devotes separate chapters to the properties, adaptability, and uses of various plastics, among them phenolic, urea, acrylic, vinyl, and ethyl cellulose.

The book also contains a chart on common faults, causes, and remedies in molded plastic parts, a directory of trade names, suppliers, and molders—and a warning to the engineer to consult the manufacturer for complete details before adopting a plastic.

**PHYSICAL SCIENCE IN THE AIR AGE (A TEACHER'S GUIDE),** *by J. G. Manzer, M. M. Peake, and J. M. Leps. A volume in the Air-Age Education Series. Published by the MacMillan Company, New York. Bibliography, index, illustrations.*

A kind of aviation geography to familiarize high school teachers with the essentials of flight so that they in turn can intelligently show their students how the principles of classroom physics and general science underlie plane construction, engines, and navigation.

Material is elementary and presented in simple sentences and diagrams, followed by lists of suggested supplementary reading and motion pictures.

**PRINCIPLES OF FLIGHT** *by Bert A. Shields. Published by the McGraw-Hill Book Company, New York. 363 pages, illustrated, indexed, $1.88.*

**PRINCIPLES OF AIRCRAFT ENGINES,** *by the same author and publishers. 378 pages, illustrated, indexed, $1.88.*

For "secondary school students who yesterday built model planes and tomorrow will pilot planes only now being designed" Lt. Comdr. Shields presents the first two books of his projected four-volume *Introductory Aviation Series.* Briefly, lucidly he outlines what every aspiring pilot must know.

The lesson begins in *Principles of Flight* with a condensed history of aviation and is followed by simple explanations of the anatomy of the airplane, forces in flight, and stability and control. Then the student goes aloft for a few printed lessons in operating a plane himself, acrobatics, and safety.

After this introduction to the art of flying, the cub pilot learns about the chief mechanism that makes it possible. *Principles of Aircraft Engines* offers him detailed descriptions of various instruments and engine parts, operation, and maintenance.

Summaries, questions, and study assignments follow each chapter in both books.

**AIRCRAFT BLUEPRINTS AND HOW TO READ THEM,** *by Carl Norcross. Published by the McGraw-Hill Book Company, Inc., New York. 102 pages, illustrations, appendix, index, $1.75.*

A short intensive text on blueprint reading for aircraft construction and maintenance mechanics by the former managing editor of AVIATION now on duty with the Army Air Forces.

Blueprint sizes, lines, title blocks, numbering systems, symbols, abbreviations, terminology, and dimensions are carefully explained by detailed references to accompanying detail, assembly, and installation prints. Review questions follow the analysis of each print. There is also a chapter on standard parts with reproductions and explanations of Army-Navy specifications and an appendix containing decimal equivalents, drill sizes, nomenclature, and symbols for electrical installations.

The material covers recommended learning for new employees.

**METEOROLOGY FOR SHIP AND AIRCRAFT OPERATION,** *by Peter E. Kraght. Published by Cornell Maritime Press, New York. 373 pages, illustrations, index, $3.*

A detailed text on vertical and horizontal winds, accompanying weather, and their affect on operations written in dilute technical language for pilots (and mariners).

Also included are sections on facts about the air, fog and other low clouds, glossaries of winds and technical terms, charts, photographs of various types of clouds, and 154 weather diagrams by the author who is senior meteorologist for American Airlines.

**FIGHTER FACTS AND FALLACIES,** *by John G. Lee. Published by William Morrow & Company, New York. 64 pages, illustrations, $1.25.*

An exceptionally lucid, nontechnical discussion of the effect of design on fighter plane performance. While man's fate hangs on his mechanical wings the subject is of more than academic importance, for, as the author remarks casually, "A second-best fighter, like a second-best poker hand, is a very bad bet."

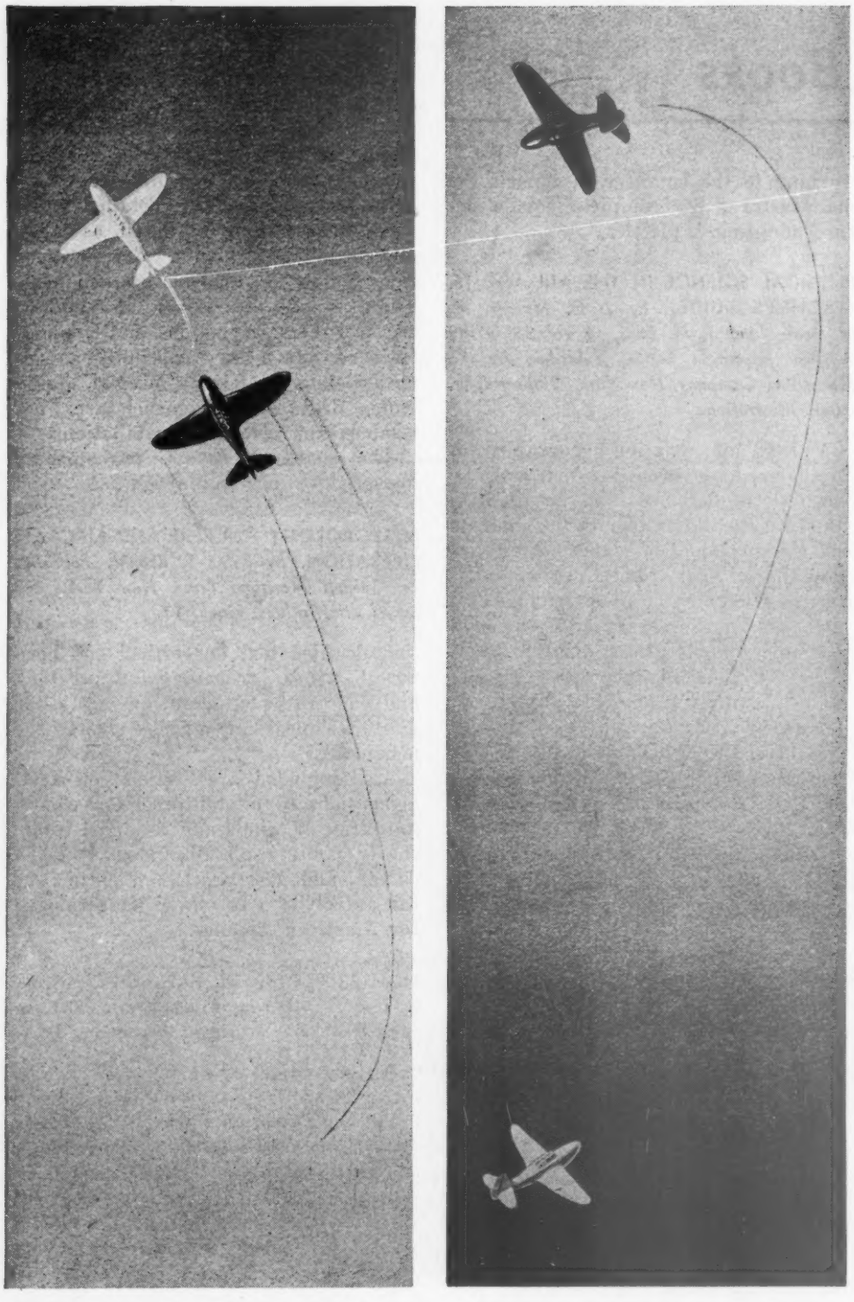
In short chapter subdivisions he analyzes the performances of various wing and power loadings, weight increases, streamlining, span loading, and propellers. Explanations are concise. Examples: "If two fighters are identical except for power, the more powerful will be the faster. This is true at all altitudes and under all conditions."

"The supercharger is essentially an air compressor."

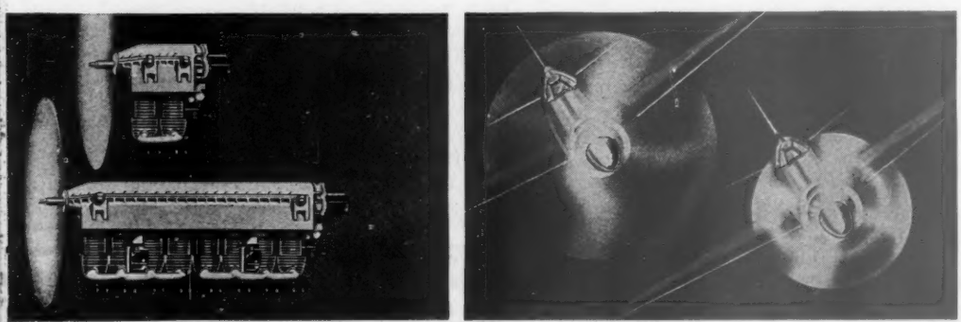
"Increased propeller efficiency is power without weight. This means improved takeoff, improved climb, improved ceiling, improved range, and improved speed."

Diagrams show each of these major points and a brief table, with accompanying illustrations, sums up interrelated performance factors.

(*Turn to page* 298)



*Illustrations like these are interspersed throughout the text of John G. Lee's Fighter Facts and Fallacies, demonstrating graphically the fundamentals of fighter design and performance. Cuts above show how with superior altitude performance, the lightly loaded plane can dive upon its more heavily loaded adversary.*



*Left: A propeller big enough to hold 2000 hp. at 40,000 ft. will hold 8000 hp. at sea level. Right: The bigger the "prop", the slower it must turn.*

"There is no 'best' fighter airplane," says Mr. Lee, the assistant director of research for United Aircraft Corporation. "With no opposition, almost any 'crate' will win the war. . . However, if the competition is close and the opponent well organized, then the specialist will win."

His book is an index and summary of laboratories of detailed facts, a catalyst to stimulate the specialist's knowledge in meeting the competition.

**PRIVATE PILOT'S HANDBOOK,** *by A. G. Norwood. Published by Pitman Publishing Corporation, New York. 258 pages, illustrations, appendix, index, $2.50.*

A former educational specialist for the CAA offers students preparing for private pilot examinations some compressed, pointed information on flight theory, meteorology, navigation, radio, flight regulations and tests, and a list of typical examination questions.

Recommended prescription for those pre-examination jitters.

**INTERNAL COMBUSTION ENGINES,** *by J. A. Polson. Second edition published by John Wiley & Sons, Inc., New York. 548 pages, illustrations, tables, diagrams, appendix, $5.*

A comprehensive text on all types of internal combustion engines with several chapters on diesel and aircraft powerplants.

"This book," says Prof. Polson, "is intended for junior or senior mechanical engineering students who have had a thorough course in fundamental thermodynamics and have a fair conception of the operation of internal combustion engines."

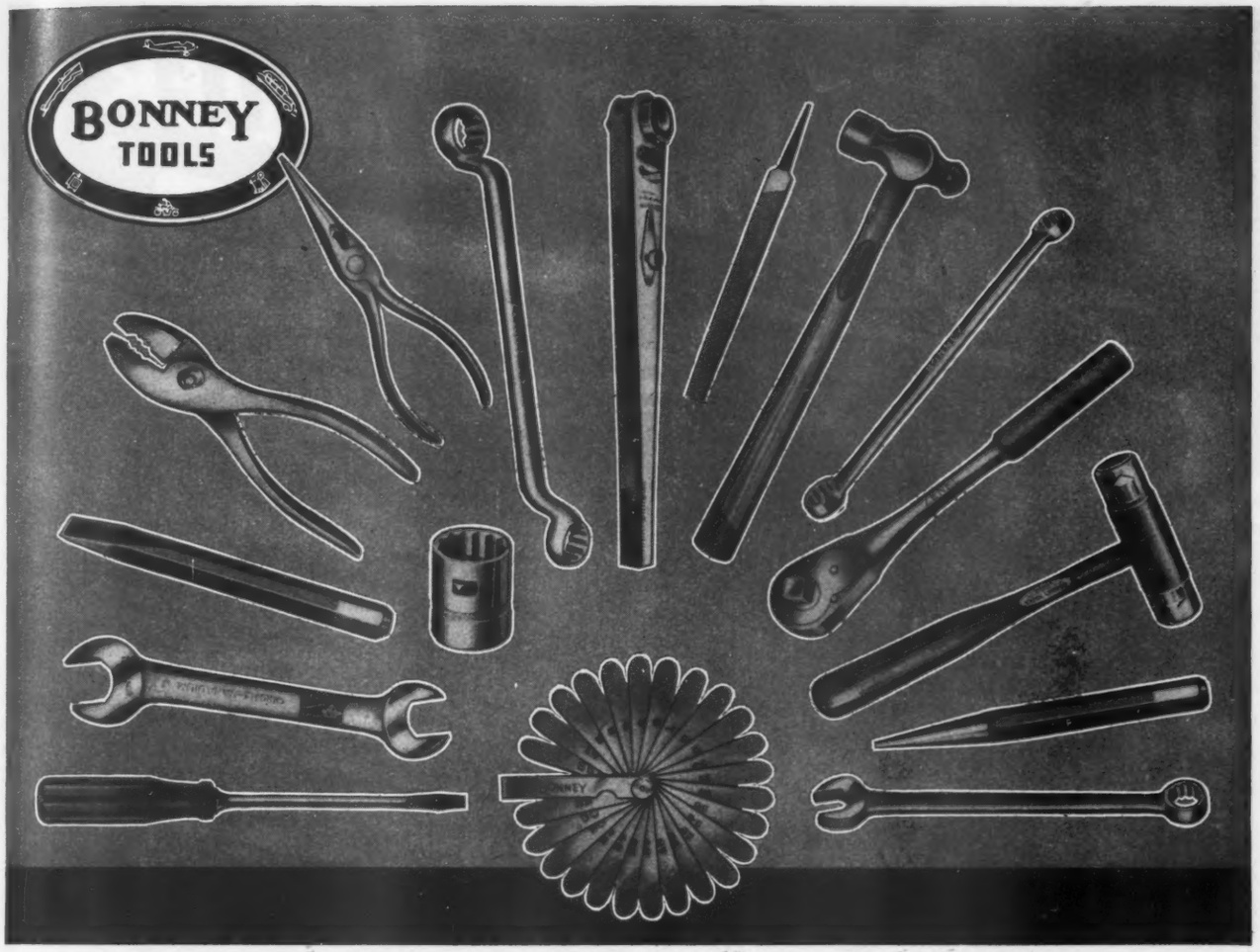
**AIRCRAFT ELECTRICITY,** *by Norman J. Clark and Howard E. Corbitt. Revised edition published by The Ronald Press Company, New York. 350 pages, illustrated, $3.50.*

A text on aircraft electrical systems for apprentice and experienced electricians, designers, parts manufacturers, and engineers.

Contains performance charts, diagrams, and standards for motors and lighting equipment, illustrations of circuits, wiring systems, conduit layouts, bonding and shielding, and chapters on design, compass deflection, and inspection and protection of wiring and equipment.

## A Correction

In the October issue of AVIATION the review of *Practical Aircraft Sheet-Metal Work* inadvertently stated the book was published by John Wiley & Sons, Inc. This was in error, as the book was published by the McGraw Hill Publishing Co., Inc., 330 W. 42nd St., New York.

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NO where—except in the the Bonney Line—will you find such a complete assortment of quality hand tools for aviation production, maintenance and service.

Considered standard by leading aviation motor manufacturers (where only quality is taken into consideration) for factory supplied tool equipment, they are also used extensively by all branches of the United States armed forces.

Awarded to the Men and Women of Bonney Forge & Tool Works "for great accomplishment in the production of war equipment".

139 types—1169 sizes to meet practically every hand tool need. You, too, can profit handsomely by using Bonney Tools to meet your production, maintenance and service requirements—the same tools that mechanics in every line of industry proclaim to be "The Finest that Money Can Buy".

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Write for big 104 page catalog showing the full line. Stocked by leading jobbers everywhere. Bonney Forge & Tool Works, Allentown, Pa.

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*The Finest that Money Can Buy*

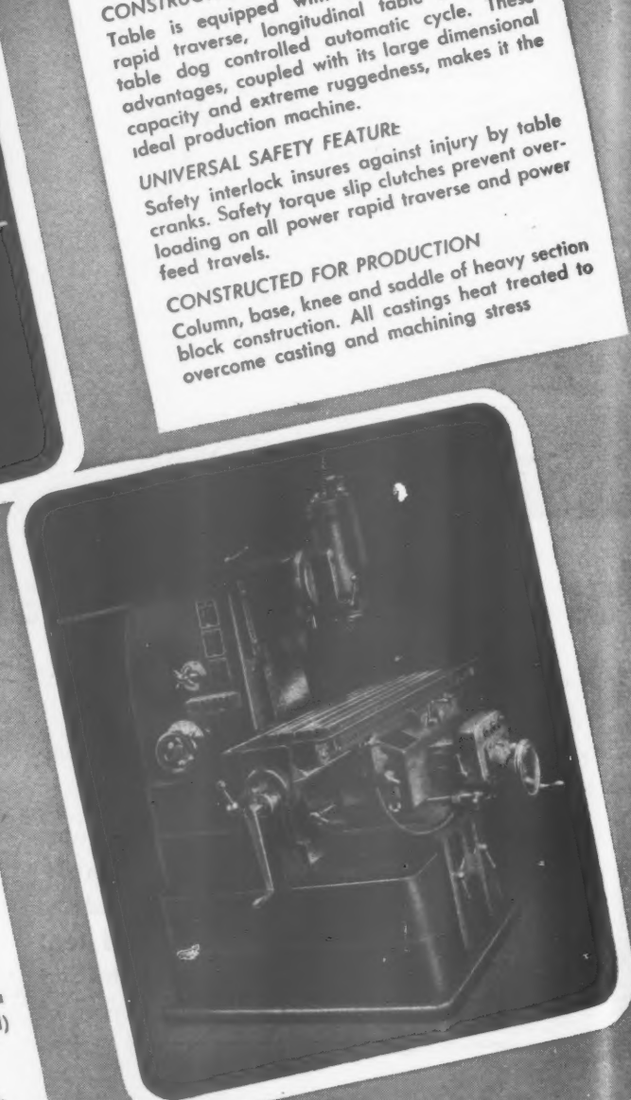
# The Lombard 2 in 1 MILLER

**THE LOMBARD 2 in 1 MILLER**
UNIVERSAL TYPE MILLER
For Either
HORIZONTAL OR VERTICAL WORK
Salient Features

CONSTRUCTED FOR PRODUCTION
Table is equipped with six direction power rapid traverse, longitudinal table travel has table dog controlled automatic cycle. These advantages, coupled with its large dimensional capacity and extreme ruggedness, makes it the ideal production machine.

UNIVERSAL SAFETY FEATURE
Safety interlock insures against injury by table cranks. Safety torque slip clutches prevent overloading on all power rapid traverse and power feed travels.

CONSTRUCTED FOR PRODUCTION
Column, base, knee and saddle of heavy section block construction. All castings heat treated to overcome casting and machining stress



FOR HORIZONTAL WORK

Three bearing mounting of the large double overarms overcomes torsion and stress in the arbor support. Overarm brace ties arbor support to the knee, which is tied to the base, giving the cutting arbor more than usual rigidity, and does faster and finer work.

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Rugged head structure, hinge mounted, transforms horizontal into swivel head vertical machine. Vertical quill is hardened and fitted in a ground bore with pick-up screw and point. Spur drive and spindle gives high torque and high speed belts transmit full spindle horse power.

The Lombard 30 HV Milling Machine is sold both as a single purpose machine (horizontal or vertical) or as the Universal Machine.

Write for folder and prices.

**LOMBARD GOVERNOR CORPORATION**
**ASHLAND, MASSACHUSETTS, U. S. A.**

## White Floors

(*Continued from page* 167)

be built or converted to aircraft production alone. And that's not counting the large hangar-floor potential which offers wide new "underside and vertical surface" vistas. Broad additional possibilities merely await the opening of "postwar doors."

Besides the values of good illumination already emphasized, these further pertinent points are listed by *Factory Management and Maintenance* (March, 1942): "Good lighting increases the effective hours spent on the job, decreases absenteeism directly or indirectly caused by eye fatigue. . . increases effectiveness of supervision because foremen can see more of their operators and more machines, can supervise more workmen. . . increases effectiveness of new workers on new jobs . . . minimizes sabotage and espionage."

"Before and after" studies have shown scrap pieces in machine shops reduced 25 percent. . . time to make fittings and adjustments reduced 15 percent. . . accidents reduced up to 25 percent. . . and production increased up to 25 percent. Decreases in errors by as much as 50 percent are indicated by a British survey in war plants.

Re Consolidated's comparative study of the white flooring *versus* the gray, *Engineering News-Record* for June 25, 1942, reported:

"When new, the white cement floor reflected 44 percent of the 36.5 foot-candles falling upon it, or 16 foot-candles. After six months use, an 18 percent loss in foot-candles is noted, bringing the reflected light down to 13 foot-candles. For the gray cement floor, the initial reflection was 27.4 percent of 36.5 foot-candles, or 10 foot-candles. After six months service, a loss of 22 percent was noted, bringing the reflected light down to about 8 foot-candles."

In short, the white flooring is credited with an 18-13 foot-candle score over the gray's 10-8 performance.

The Consolidated plant in question is lighted with two-lamp RF-type fluorescent units spaced 8 ft. 4 in. along the truss and 12 ft. 6 in. lengthwise (twin units on 25-ft. centers). Having obtained, with the white flooring, an even distribution of light below, as well as above, wings of planes, cumbersome flood light equipment is needed only for fuselage interiors.

There are 6,720 two-tube fixtures in the white cement area. However, it was determined that had this floor been of gray concrete, like the adjoining floor, 20 percent more fixtures (at $33 net) would be required to give the same level of illumination. That bill would be $44,352. Then maintenance of the additional fixtures (two tubes each, three times per year) was put at an extra $14,515, while the extra electricity would come to $12,067. Total: $70,934.

Accordingly, since the extra cost of the white floor in this plant was approximately $40,000, a saving of $30,934 is recorded the first year on fixtures, maintenance, and power. And each year thereafter, the white cement yields a return of $14,515 in lamp maintenance plus $12,067 in power, or more than $26,000.

Of course, costs in another plant would be higher or lower depending on the specific conditions encountered. Also, costs of white cement floorings vary in different localities.

The figures on potential air conditioning saving necessarily are but a broad approximation based on the saving of about one ton of air conditioning each time the lighting load is reduced 3½ kw. Additional energy converted into light and consequently heat by a 20 percent increase in lighting fixtures necessary for a gray floor gave an extra air conditioning cost, on a kilowatt calculation, of $19,750. To this figure, in the saving column, could be

● To win our share of this war we've got to tighten up—toughen up. We've got to funnel the work of three hours into one. Today production finishing requirements become more and more critical. The demand for speed and more speed becomes more insistent. That's why it is imperative to leave no stone unturned to find the finishing materials and methods that will push your production up to the peak you have to hit and keep it there.

It will pay you to learn why McAleer metal finishing materials and methods are performing such outstanding service for the leaders in your industry today—and, more important, how similar materials and methods can solve your metal finishing problems.

McAleer will work with you—recommend "tailored-to-fit-the-job" materials and methods—and then follow through as needed. The value of this service is already written in the finishing production records of many manufacturers who are working today under greater pressure than ever before. McAleer's Finishing Engineers and laboratory staff have helped them bust some pretty tough production bottlenecks . . . and usually with a plus of increased production, better finish and lower operating costs. It's the kind of a job we want to do for you.

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Castolin Eutectic

LOW TEMPERATURE WELDING

IMPROVED METHOD FOR WELDING CAST IRON

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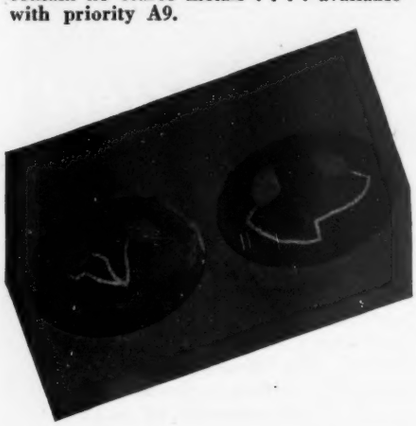
WAR plants the country over rely on Castolin Eutectic Alloy #14* (for gas welding) and Castolin Eutectic Alloy #24B* (AC-DC metallic arc) for easy, reliable welding and reclaiming of broken, cracked, worn, or defective castings. These new low temperature welding alloys give a completely machinable, color matching weld — free from stresses and distortion.

Use Castolin Eutectic Low Temperature welding alloys #14* and #24B* in place of "hard-to-get" bronze welding rods. Castolin Eutectic Alloys #14* and #24B* contain no scarce metals . . . . available with priority A9.



Cast Iron covers salvaged with Castolin Eutectic Low Temperature Alloys.

CHECK THESE ADVANTAGES:

- *High strength*
- *Matching color*
- *Less stresses*
- *Less warping*
- *Less preheating*
- *Greater economy*

*Patented

Some territories available for Manufacturer's Representatives

EUTECTIC WELDING ALLOYS CO.

40 Worth St. New York, N. Y.

added an estimated $3,500 in operating charges for electricity, or a total saving of $23,250.

Approximate though these figures are, it is evident that the white cement floor is a factor to be considered when designing and estimating the cost of an air conditioning system.

An addition to a plant's lighting load is often a problem as well as a considerable expense in itself. Savings here, through the use of white flooring, are indicated. Needless to say, added electrical equipment for lighting and air conditioning would call for quantities of currently critical materials. Priorities are also to be considered.

But white or light-colored sand and stone and white cement are readily available.

Finally, it may be emphasized that the "floor is the factory." There are few places in a plant where it does not pay big dividends to have an adequate, substantial, and durable floor. "Saving" on floor construction is poor economy, since an unsatisfactory floor slows down production.

It is, of course, the top surface of a concrete flooring which takes the wear and grind, and for that reason careful placing and curing of good concrete is essential. The properly laid concrete floor will resist extremely severe conditions indefinitely, and it will not suffer from that most troublesome floor disease known as "dusting."

With white concrete, color is highly important. Stains not only are unsightly, but they may decrease the reflecting values. So it is that practices and materials which may be satisfactory for a gray floor may not be satisfactory for a white one. In placing, finishing, protection, curing, and maintenance, the use of machines, tools, trowels, materials, or practices which may stain or soil the flooring should be avoided.

## Altschul

(*Continued from page* 249)

### Utilities May Point Pattern

This reduction in rates was accomplished either by voluntary action or by regulatory moves; frequently it was a combination of the two. On the one hand, constant technological progress made it possible for the power companies to reduce their rates so as to broaden their markets. In many instances, however, the regulatory bodies determined that the utilities were earning "excessive" profits and realizing too large a return on invested capital and forthwith took action to force the rate structure down.

A careful perusal will disclose that these same elements are present, in large measure, in the case of the airlines.

It is inevitable that great technological strides will be experienced by commercial aviation after the war. This should permit substantial operating economies and thus make possible rate reductions for the carriage of passengers, mail and express. This, in turn, will materially enlarge air transportation's market.

Should the airlines be slow to effect voluntary rate reductions when they are in a position to do so, it is only necessary to look at the regulatory processes for the possible course of events. The Civil Aeronautics Board has indicated its intention of reducing mail compensation so as to limit airline earnings to a return of about 10 percent on invested capital. This principle was definitely indicated in the Pan American-Grace Airways decision and, to a lesser extent, in the American Airlines case. The board was clear in indicating that this policy, i.e., a limited return on capital, was being followed only as a war expedient and that "a return to normal incentives to attain the best possible commercial service" would be made upon the conclusion of the war, or perhaps earlier. It must be apparent that the application of this policy places a virtual ceiling on airline earnings. What a 10 percent return on capital can mean for the major lines is indicated in Table I. Regardless of what subsequent action is taken by the board, the regulatory existence is strong and clear and federal supervision will remain with the industry as long as it is vested with such a substantial public interest.

Should further evidence be desired that airline rates will eventually trend downward, voluntary or otherwise, it is only necessary to look at another transportation medium—the railroads. According to Chairman Splawn of the Interstate Commerce Commission, the decline in railway rates since 1929 was largely the result of voluntary reductions brought about by competition of other agencies of transportation, and that competition prevented the restoration of the higher rates. (This statement was made in 1939, prior to the adjustments caused by war conditions.)

### Competition Assured

The airlines themselves will be in a highly competitive field and have no assurance of having the transportation market under their dominance.

True, luxurious air transport equipment of the immediate future promises to have twice the capacity and about one-half the operating cost of existing planes. This factor should permit a reduction in the present passenger tar-

(*Turn to page* 305)

# Ryan Manifolds *Fight* on every front

The specially built exhaust systems of the Douglas A-20 Havoc and Boston attack bombers are one of the vital factors in their combat effectiveness and high performance. In every air battle the A-20s have shown superior striking power and ruggedness under fire. Contributing to the deadly efficiency of these remarkable planes, Ryan builds the exhaust systems that control the gas and heat of their mighty engines. Similar Ryan manifold systems are standard equipment on scores of other United Nations combat and cargo planes now fighting on every front.

*Exhaust Systems Manufacturing Division*

**RYAN AERONAUTICAL COMPANY, SAN DIEGO, CALIF.**

Member, Aircraft War Production Council, Inc.

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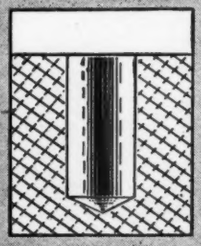
The Ryan Exhaust Systems Manufacturing Division specializes in heat transfer problems. Ryan assembly lines are models of flow production.

RELY ON Ryan
A NAME OF MILITARY SIGNIFICANCE

1922 A Leader in Air Progress for Twenty Years 1942

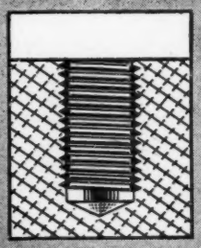
# TO PREVENT ALUMINUM THREAD STRIPPING . . .

## SIMPLE AS ABC!



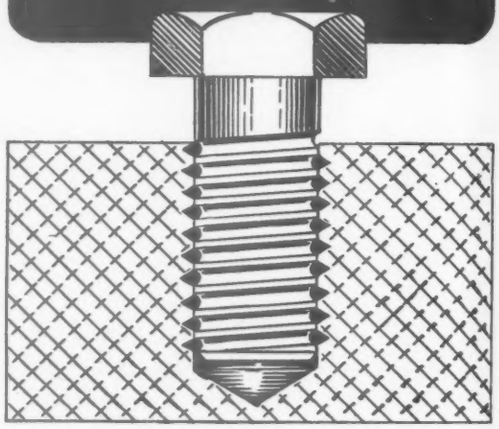
**A** Drill out old thread with drill having limits within plus .000 and minus .005 of diameter of Aero-Thread stud to be used. Depth of hole should be at least twice diameter of stud plus 1/8".

**B** Clean out and tap with Aero-Thread VAT Tap of proper size. Make sure that full depth of hole is tapped and that center line of tap is at right angles to face of boss when tapping.



**C** Place correct size insert over shank of inserting tool, with tang in slot of tool. Screw insert into tapped hole in clockwise direction. When insert is in position, shear off tang by reversing rotation of inserting tool about a half turn.

## Replace with Aero-Thread* INSERTS



*Aero-Thread Cap Screw in position in aluminum alloy boss. Note that thread profile of the screw has a circular valley and the tapped hole a modified 60° Vee thread form.* *Trade Mark Reg. U. S. Pat. Off.

THE Aero-Thread Screw Thread System provides a thread lining for the tapped hole which also engages the threads of the mating screws. These inserts are made of hard, smooth, precision-shaped wire in stainless steel or phosphor bronze materials. Protection of tapped threads in light metals such as aluminum or magnesium, against wear and abrasion, is obtained at low cost with Aero-Thread Inserts. Holding power in light alloys and plastics is substantially increased and stripped threads eliminated.

Aero-Thread Screws and Studs, with their circular section thread form engaging the insert, have 100% greater fatigue resistance and 25% greater static strength than similar parts conventionally threaded.

The Aero-Thread System is standard for replacement on combat aircraft engines, thus eliminating the oversize stud nuisance. It greatly simplifies field servicing. Expensive engine casings have been salvaged with the Aero-Thread System after they had been rejected for stripped threads. It is also used in original installations in aircraft engines, carburetors, oil filters, magnetos and other products. Send for Bulletins T-1A, No. 234 and Catalog No. 5.

*U. S. Patent Nos. 2,150,875; 2,150,876; 2,152,681; 2,210,061; 2,244,824; 2,262,450; 2,257,089.*
*British, Canadian and other foreign patents issued and pending.*

AERO-THREAD

**AIRCRAFT SCREW PRODUCTS COMPANY, INC.**
47-23 35th STREET • LONG ISLAND CITY, N. Y.

(*Continued from page* 302)

iffs of about 5c. a mile thereby broadening aviation's potential market. Present railroad passenger fares call for an average of 3.3c. per mile in Pullmans and 2.2c. a mile in coaches.

But while the airlines are progressing, will the railroads be standing still? Most likely not. Cheap and abundant supplies of aluminum and magnesium can produce strong, lightweight railroad passenger car equipment just as well as sturdier and lighter air transports. Further, short cuts in production techniques will not be confined to airplane manufacturers. It is not beyond the realm of probability that air conditioned luxury coaches with every conceivable convenience will provide low cost, rapid transportation and yet return a profit to the steam carriers.

Not to be overlooked is the progressive management influence that has already proved itself in railroad affairs. The trend which produced the streamliner, tourist trains with new comforts and coach cars better than the old-style parlors, will most likely continue and produce a few more innovations. The present war prosperity is constantly strengthening the railroad industry's condition—both financially and physically. These substantial cash resources and the excellent property condition now prevailing may stimulate the railroads to venture forth with new and bold ideas to not only retain their passenger business but to attract additional patronage as well. All these factors may conspire to make the passenger transportation field far more competitive for the airlines than is now popularly supposed. In equal measure, similiar conditions may apply in future air express and cargo operations.

### Greater Coordination

It is difficult to overlook the fact that the country's railroad plant represents an investment of about $32,000,000,000. By contrast, the domestic air transport group last reported total resources of about $70,000,000. While discounted to a material extent, railroad investments still bulk large in the portfolios of insurance companies and banks, and the cry may go out to protect the interests of the "widows and orphans."

Further, the political pressure of about 1,300,000 railroad employees and their families receiving an annual payroll of more than $2,300,000,000 is more potent than the working forces of the airlines, which at last count aggregated about 25,000. Moreover, the railway brotherhoods have demonstrated their ability to secure and protect special benefits for their membership.

The future pattern of air transportation may also be conditioned considerably by broad, national objectives. It is possible a greater degree of coordination may be sought between the airlines and the railroads along with other forms of transportation. Coordination of all types of transportation has long been sought by government authorities and may achieve a greater degree of success than heretofore under the guise of postwar planning. (Since this was first written, the National Resources Planning Board advisory committee has proposed the creation of a National Transportation Agency to coordinate development of all transportation facilities—railroad, air, highway and water—after the war.)

The air transportation industry will undoubtedly experience a material expansion in volume operations once the war is over. The growth trend will probably remain upward for some time to come. It is important to note, however, that the airlines will not be without their problems and will have need of all the ingenuity which made possible their growth as a medium of first-rank importance in the country's economy.

## Cargo Markets

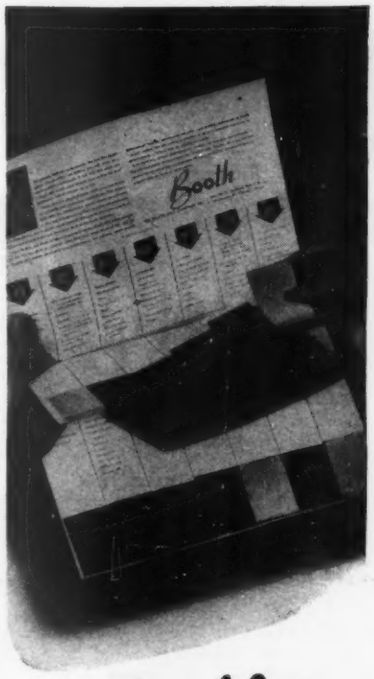
(*Continued from page* 246)

cure can be set up, *but* it is of extreme importance that this structure be sufficiently high to permit the introduction of "specific commodity" rates lower than the base, for it is by this means that the airlines will ultimately develop their own tariff structure. The "specific commodity" rate must at all times cover costs of operation, although not all overhead or profit, and it will help fill planes, raising percent of payload, bringing out new business which will prove more and more profitable as costs go down. The shipper has been well educated in commodity rates by all ground transportation companies and will not be backward in submitting his ideas if he sees a possibility of a rate which will enable him to move his goods by air.

### Commodity Analysis

Another important phase of the problem might be called a "commodity analysis." The airlines need not be content with merely attempting to get a large portion of the express business because there are several factors in air transport which will enable them to carry goods now moving LCL and, in some cases, to create new markets.

Commodities of high intrinsic value are particularly adaptable to air transportation since the poundage charge is of less importance in relation to the value of the goods. It has been amply


Working Tools

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Complete specification tables are included . . . and the kit is bound standard file size. Write for it...no obligation . . . no sales follow-up.

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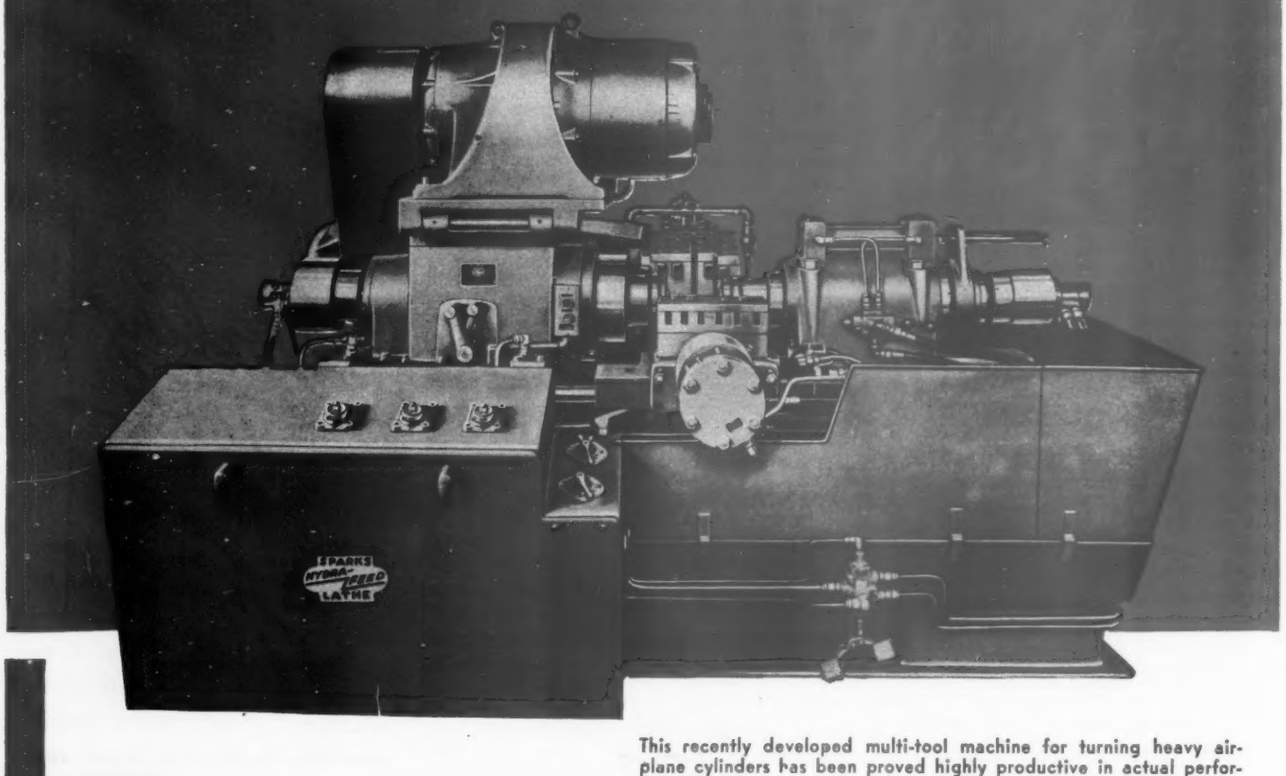
1907

# ANNOUNCING

## THE New SPARKS SEMI-AUTOMATIC TURNING LATHE




**FOR HEAVY-DUTY AIRPLANE CYLINDER PRODUCTION**

***Write today for Descriptive Bulletin giving full information***

This recently developed multi-tool machine for turning heavy airplane cylinders has been proved highly productive in actual performance.

It is arranged to accommodate six turning tools on the front cross slide for main body turning and employs a hydraulically operated cartridge tool holder mounted on cross slide. Six tools are also mounted on back slide which also moves in and out of the work automatically. The cylinder is gripped on both ends by a specially designed holding mandrel.

A roller-bearing quill expanding arbor, attached and fitted to quill, is expanded automatically by separate hydraulic cylinder. Quill is traversed backward and forward by connection to hydraulic cylinder mounted on top of tailstock.

All feeds are controlled through conveniently located metering valves on front of machine. Holding equipment is operated through a foot treadle valve on front of machine and permits quick recovery of finished cylinder as well as rapid gripping of rough cylinder about to be turned.

Headstock, roller and ball bearing equipped throughout, provides four selective speeds for turning various size airplane cylinders. A reducing gear motor makes it possible to bring speeds down for turning cylinders of exceptionally hard material.

SPARKS HYDRA-FEED LATHE

**SPARKS** MACHINE TOOL CORPORATION
NORWALK . . . . CONN.

demonstrated that higher priced articles can absorb higher transportation costs, as has been shown by watch part shipments from Switzerland to the United States, platinum shipments from Colombia and gold shipments from Peru, British Guiana and Brazil.

A careful geographic analysis is also required, the clue having already been given by our prewar movement of commercial goods. As important as distance are mountains which, although presenting peculiar operational factors to air as well as to surface transportation, have been an important factor. There is, for example, Colombia, a small nation honeycombed with airlines as well as mountains. Air cargos there already run into millions of pounds a year. Eastern Bolivia and the Brazilian Matto Grosso are being opened up by airlines which are creating new markets. In this territory the commodity rate tariff already lists—at a few cents a pound—items ranging from jerked beef through fresh vegetables to school textbooks, all of which are moving by air in substantial quantities.

Still another part of the geographic analysis involves points now served by circuitous routes or those involving multiple transfers. For example, air transport from Buenos Aires, capital of Argentina, direct to Sao Paulo, chief industrial city of Brazil, is but a matter of a few hours, whereas boat service requires a trip of several days around Uruguay to Santos, where the shipment must be offloaded and then moved by cable railway up 3,000 ft. to Sao Paulo for a second unloading. Here the advantage of the aircraft is measured not only in time, but in distance traveled and the number of times the shipment must be handled. Non-stop flights over the great circle route direct from Chicago or Detroit to London with similar advantages in time, distance and handling are within the realm of possibility upon, or soon after, resumption of commercial air transport. Shipments from inland United States points to inland European cities involving stops will still offer the same advantages for *Airex* shipments.

## Other Factors Favor Airex

Inventory, warehousing costs, credits and financing each represent important factors in air transportation's future, but they are so closely related that they are here treated together. The speed of air transport will enable the merchant to radically reduce inventories, especially of goods in the "slow moving" categories. This reduction can result in an over-all lowering of inventory, or permit the merchant to increase the number of items in stock while still maintaining the same investment and enjoying a wider range of goods for sale and much quicker turnover. Such transportation can largely eliminate the need for tying up capital in overstocking items which may eventually have to be liquidated below cost.

With faster turnover, credit terms can be shortened, even to the point where the merchant can take advantage of cash discounts. The proverbial Latin American "No hay"—we haven't it—can be changed to "Si, tenemos"—"Yes, we have it," or, at most, to "We'll have it tomorrow."

It is axiomatic, but not less important, that the more rapid the turnover and the smaller the stock of each item, the smaller will be the losses from depreciation and theft. Warehousing, with its initial costs, plus depreciation and theft losses, is even more important to the producer than to the retailer. To cite but one specific case, a machine tool manufacturer told the writer that with lowered costs for air transportation he could eliminate 25 branch warehouses and still give service equal to or better than that he is offering now.

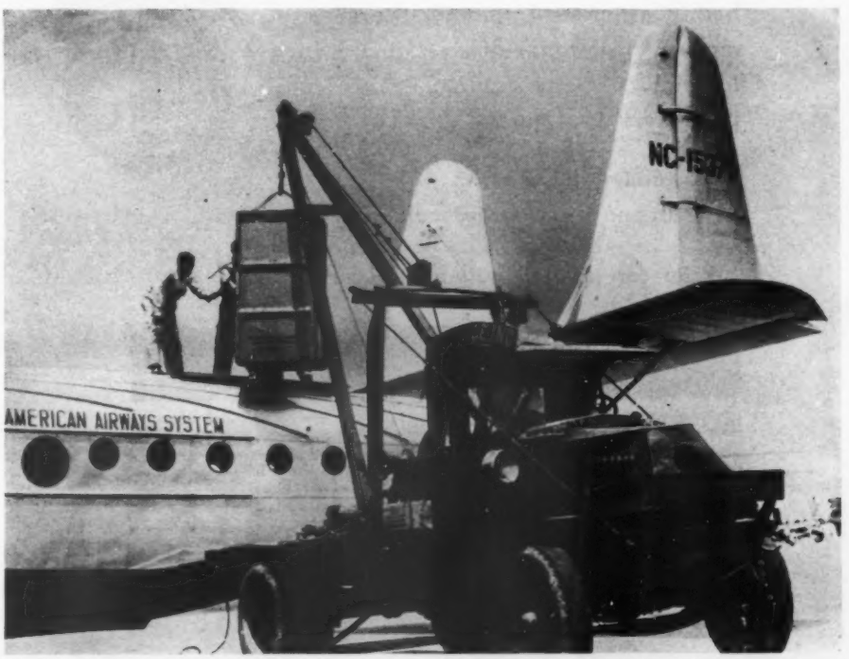
## Ground Handling

The operations departments of the airlines will be chiefly concerned with ground handling problems involving adequate loading, storing and trucking facilities. Nevertheless, it is a major problem from the standpoint of those charged with developing and maintaining traffic.

It seems obvious even now that a uniform system of door-to-door service must be established if *Airex* is not to lose a great part of its advantage. This means that the airlines all over the world must cooperate—as have the railroads in this country—to permit a shipment to move by the most direct route to destination by transfer from one line to another.

It would appear also that the lines themselves must solve the problem of getting shipments to and from airports, for thus far there has been no uniformity in this procedure. For straight air express in this country, the Railway Express Agency has been doing the job. In other countries the procedure varies from the shipper having to call for and deliver his goods, to procedures where the airlines themselves afford pickup and delivery with their own trucks. Also, before the airlines can begin to think of carrying the equivalent of carload freight, they must devise a means of loading at factory sidings as is done today in thousands of plants which have their own sidings and who in some cases do their own loading.

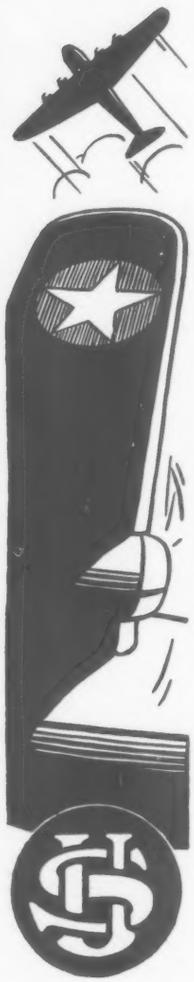
If the operations departments of the airlines decide to handle their own pickup delivery it will involve an investment of many millions and the building up of a formidable organization just for this end of their business. They may delegate this function to one or more agencies, but the operations end must consider this feature. It is a traffic need but it will be up to the




*While ground handling will be chiefly the concern of operations departments, it will also be a major problem for those charged with developing and maintaining traffic. Door-to-door service already appears an obvious necessity to meet competition of present surface transportation systems.*

# UNITED STATES
# AIRCRAFT SPECIAL DRILL

***This Drill gets into the tightest places . . . and deserves credit for doing so***



**MODEL ARD The pet of the aviation industry because of its amazingly flexible use where "ordinary" drills fear to enter. It's quite a handful for such a little fellow.**

**Universal motor, 750 to 5,000 r.p.m.; ball bearings in steel retainers, easily removed; close-coupled; air-cooled; switch for right or left-handed users; streamlined from tip to tip.**

***Easy inspection, adjustment or parts replacement***

***Write for details, without obligation.***

*United States Electrical Tools*

DRILLS • DRILL STANDS • VALVE SEAT GRINDERS • VALVE REFINISHING MACHINES • VALVE REFINISHING SHOPS • PORTABLE SURFACERS • PORTABLE SANDERS • FLEXIBLE SHAFT MACHINES LATHE GRINDERS • GRINDERS • BUFFERS • POLISHERS

THE GOOD MECHANIC'S CHOICE

THE UNITED STATES ELECTRICAL TOOL CO.

CINCINNATI, OHIO, U.S.A.


operations department to find the solution and put the new plan into effect.

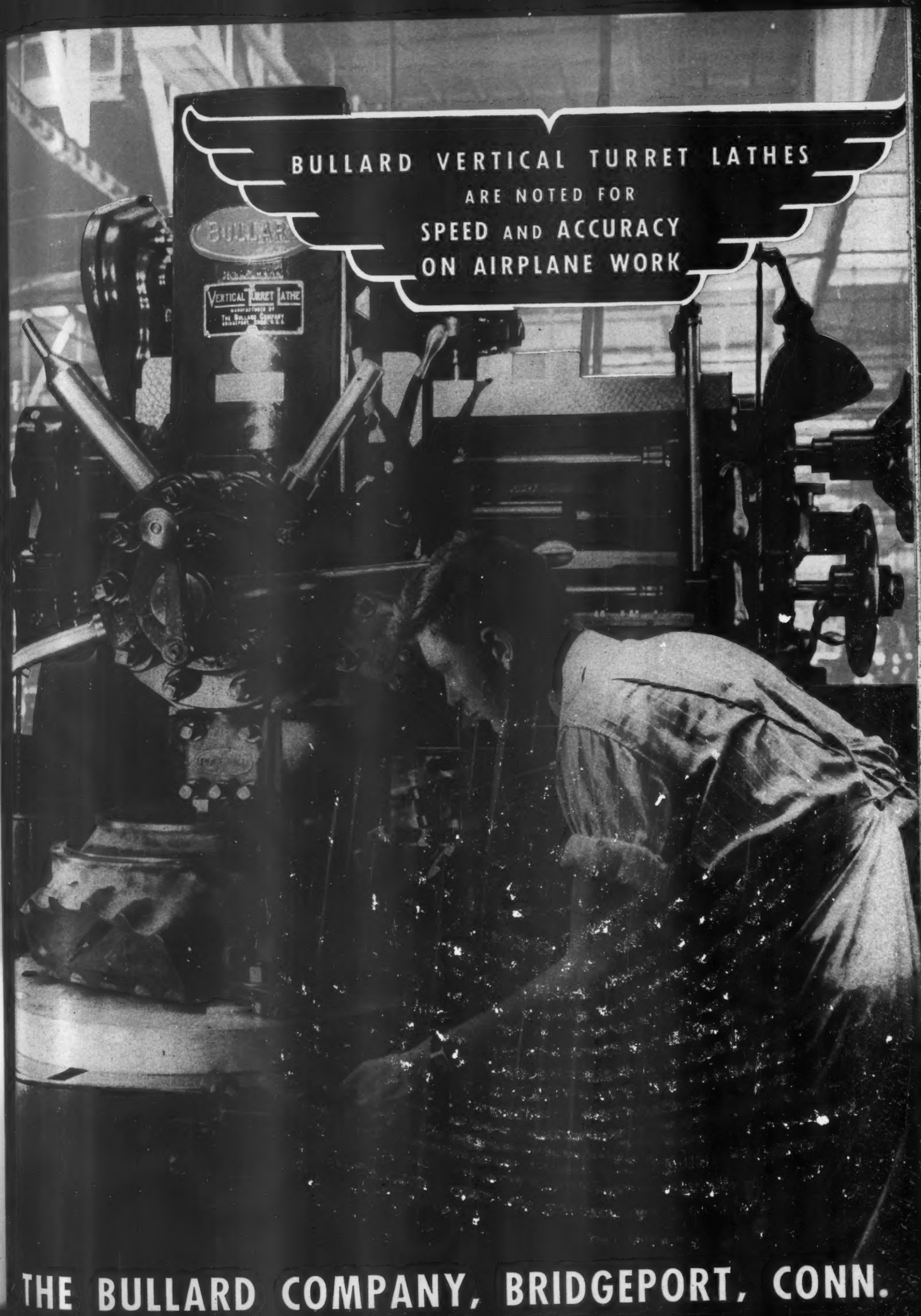
### Selling the Service

Even though the airlines come out of the war with far better equipment than ever before, with a wealth of "know how" on cargo handling and a greater public knowledge and acceptance of the airplane as a means of transportation, they will still have to sell their service. Knowing something of the traffic problems to be faced and solved in the coming years of expansion, the airlines can make their work much easier if they set up an efficient sales force to guide the shipper. This should not be a group of traditional salesmen who obtain their business by good will and entertainment. It must be a group who are experienced merchandise and traffic men. It will be their duty to explain the advantages of speed, service, warehousing, financing, credits, and new markets which *Airex* can give the shipper. These salesmen must be constantly on the alert for new openings and new markets. They must be an integral part in the trinity of operations, traffic and sales.

### New Markets

Improved equipment will greatly expand the list of *Airex* commodities, but the ultimate limits will depend a great deal on sales which will develop new markets. Air express as it is today has already created some new markets and *Airex* will accelerate this process. After considerable study and collaboration with Pan American Airways, *Time* magazine introduced a Latin American edition which today has a circulation of over 20,000 copies weekly and is on sale at most Latin American news stands on the same day that the American edition goes on sale in New York, Washington or San Francisco. Today in Buenos Aires, one can eat lobsters and oysters which have just been flown over the Andes from Chile. One of the large New York newspapers has studied the possibilities of delivering a special edition throughout the United States daily. Cuba has built up a large demand for Easter carnations from the United States; orchids have been flown here in increasing quantities from Latin America. The fragile and delicious papaya, which must be picked when it is dead ripe, can now be put on northern tables.

Lower *Airex* rates, made possible by new equipment, operating efficiency and volume sales, will make it possible for the business man to find new outlets for a growing list of both essential and luxury products, outlets which will help keep America's airlines the finest in the world.


BULLARD VERTICAL TURRET LATHES
ARE NOTED FOR
SPEED AND ACCURACY
ON AIRPLANE WORK
BULLARD
VERTICAL TURRET LATHE
THE BULLARD COMPANY, BRIDGEPORT, CONN.

# This new tracing cloth defies moisture stains and erasure scars

This new tracing cloth won't show perspiration stains or water marks—*holds pencil smudges and erasure scars at a minimum.* Now you can have clean tracings, in pencil or ink, free from these untidy "ghosts" that reproduce on blueprints!

For PHOENIX is ghost-proofed by a remarkable new process that defies moisture and gives you an unusually durable working surface. You can use harder pencils with this improved cloth and get sharper lines with less tendency to smudge. Even 6H lines show clearly, and reproduce sharply! Erasing does not mar the drawing surface; erased areas take pencil smoothly—and ink without feathering. Its new white color and increased transparency give you excellent drawing contrast and produce strong blueprints.

Put PHOENIX through your own drawing board test. See your K&E dealer, or write for a generous working sample and an illustrated brochure.

**PHOENIX DEFIES MOISTURE GHOSTS . . .**

Perspiration and water splashes on ordinary tracing cloth create "ghosts" which reproduce on blueprints. PHOENIX Tracing Cloth withstands actual immersion in water for fully 10 minutes at a time! *Perspiration and water marks will not stain it!*

**PHOENIX LESSENS SMUDGE GHOSTS . . .**

The new improved surface of PHOENIX Tracing Cloth permits you to use harder pencils (5H and 6H) and to get sharper lines with less tendency to smudge.

Result: Cleaner tracings and blueprints.

**PHOENIX REDUCES ERASURE GHOSTS . . .**

Ordinary tracing cloths become scarred when erased . . . erased spots produce ghosts on blueprints.

PHOENIX has a durable drawing surface that reduces working scars to a minimum.

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**TRACING CLOTH**

**for pencil *and* ink**

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CHICAGO · ST. LOUIS · SAN FRANCISCO · LOS ANGELES

DETROIT · MONTREAL

## Navy Pilots

(*Continued from page* 241)

cooking utensils, and living quarters. And they are flown differently, too, by wheel and yoke instead of stick.

The PB's comprise a command of which any junior officer may well be proud. Here, varied ability, intelligence, ingenuity, and resourcefulness are demanded.

All this is part and parcel of naval aviation training, liberally dosed with Link Trainer work, instrument flying, night navigation, formation practice, free gunnery runs, camera firing, and bombing practice—together with certain other matters aeronautical which the Navy understandably does not publicize, this being wartime. Indeed, being commissioned as a flying ensign is no longer quite enough. The pilot must receive three additional months at any one of a dozen operational bases before he is ready to join the fleet.

As a flying officer, the Navy pilot must be both versatile and immediately familiar with the missions and mechanics of all types of combat craft. But again, that doesn't suffice. He still must receive battle training from war-tested pilots returned from across the Pacific. He also must learn to recognize *immediately* the silhouettes and characteristics of both enemy and friendly ships and planes. He must be able to fire four guns and a cannon at once, to spot shells, to effect cast recoveries, and to know code and radio procedure. A flying fighter, yes—but also a walking military encyclopedia.

In this war, naval aviators are much more than the "eyes and guns" of their fleet. Look at the record. They're the first line of attack across the seas. They're the capital "V" in Victory.

## Accumulator Systems

(*Continued from page* 155)

the hydraulic system can be scavenged out by cycling the accumulator a few times. In order to prevent air from the system from entering the accumulator the system can easily be scavenged by operating all the equipment below the pre-load pressure of the accumulator thus driving the air into the reservoir.

Various methods of mounting the accumulator in the airplane have been worked out. In the case of the floating piston unit, the problem is easy. Simple clamps can be devised for this purpose. In the case of the spherical accumulator, the problem is not so simple. Fig. 9 illustrates various methods of mounting now in use and Fig. 10 demonstrates methods used to mount the bottle type unit.

...NOW STEPPING UP WAR DELIVERIES

1. **They save the worker's time**
Each nut is a self-contained easy-to-handle unit that goes on fast . . . and its self-locking action is immediate and automatic.

2. **They eliminate the dangers of careless assembly**
The locking element is built into the nut . . . no pins, wires, washers, or shims that can be forgotten or incorrectly applied.

3. **They reduce inspection needs**
With less operations and less parts to be checked . . . there's another important saving in man-hours.

There are more Elastic Stop Nuts on America's airplanes, tanks, guns, Naval vessels, and production equipment, than all other lock nuts combined.

» *Write for folder explaining fully the Elastic Stop principle*

ELASTIC STOP NUT CORPORATION
2320 VAUXHALL ROAD · UNION · NEW JERSEY

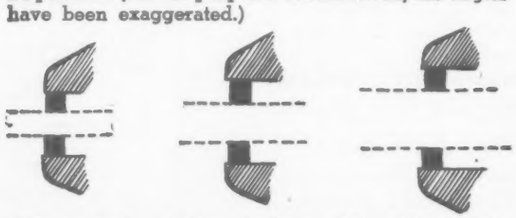
# *New* CLECO 41-L Squeezer

## *with parallel jaw action*

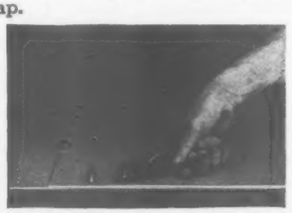
## THAT INSURES BETTER RIVETING

★ **The faces of the riveter arm dolly and the anvil arm dolly of the Cleco 41-L Alligator Squeezer are *always parallel regardless of the amount of gap.* This exclusive feature prevents disalignment ("clinched rivets") and loss of rivets; it insures tight rivets with uniform heads, and does not cause distortion in the surrounding metal. ★ The 41-L is new in design, but is built to the same uncompromising quality standards that have distinguished Cleco Tools for so many years. This squeezer is light and powerful; it weighs only 5½ lbs., is 12¼" long, and has a ⅛" rivet capacity. The working gap is 15/16", with full opening of 1½". It is equipped with automatic return throttle, and adjustable pressure "pop-off," as well as return limit stop on alligator jaw. ★ To meet your wartime production schedule you can't afford to be without this unique squeezer. *Write now for complete information.***

● These sketches show how the faces of the dollies on an ordinary squeezer are parallel when the gap is small. But as the gap increases, the faces cease to be parallel. (For the purposes of illustration, the angles have been exaggerated.)



● In contrast, note how the faces of the dollies on the 41-L Squeezer are *always* parallel regardless of the amount of gap.



● The New Repairable Cleco Sheetholders with Latest Design Pliers.

**THE CLEVELAND PNEUMATIC TOOL CO.**

BRANCH OFFICES IN ALL PRINCIPAL CITIES

MARBLE AVE., AT EAST 77th ST. CLEVELAND, OHIO

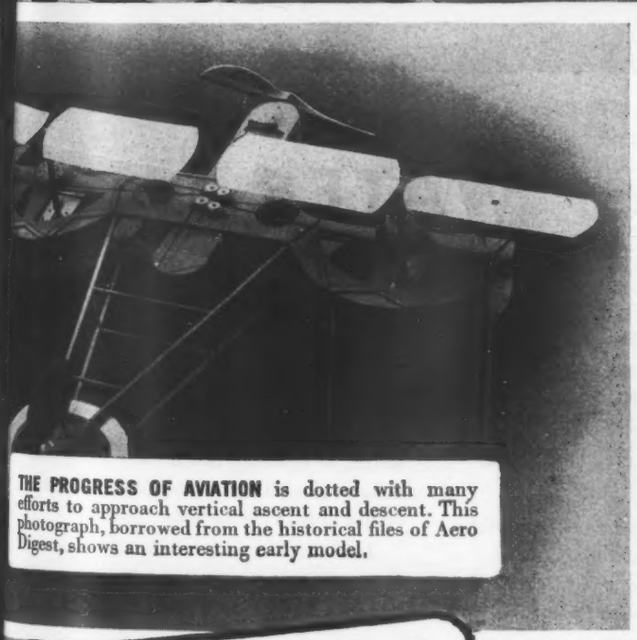
# YOU'RE ALWAYS TRYING SOMETHING NEW

THE aircraft industry never stands still. It has its memories... as these photographs show... but no molasses-in-January traditions. Even in the old photographs pictured here... and in every one... there is the healthy sign of something new being tried... new methods, new devices, new materials. Recent among the new materials aircraft engineers have successfully used is plastics, and of many plastics, Synthane is a versatile one.

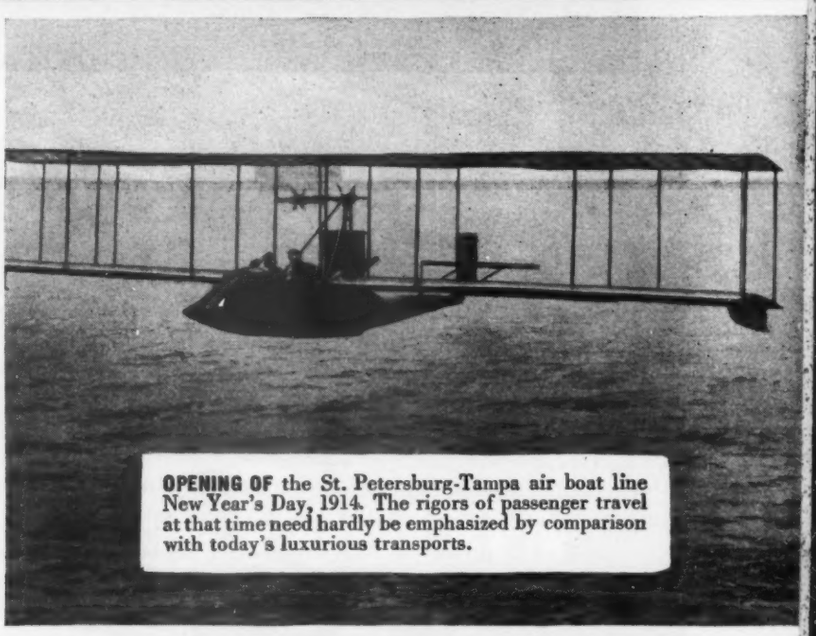
Synthane Bakelite-laminated is a thermo-setting plastic with many properties desirable in low stress primary and secondary aircraft parts. Chief among these properties are light weight (half the weight of aluminum) resistance to corrosion from aviation oils and gasoline, water and many acids, structural strength, resistance to change in shape with change in temperature, excellent electrical insulating characteristics, and its comparative ease of machining.

**SYNTHANE CORPORATION, OAKS, PA.**

**EARLY MODEL OF THE "VERTAPLANE"** undergoing inspection by its inventor, Gerard P. Herrick *(left)*. Mr. Herrick a captain in the U. S. Army Air Service during the World War, later succeeded in combining —in one machine—the efficiency and speed of a fixed wing airplane with the convenience and safety of a rotating wing type by releasing and rotating an upper wing surface. His machine is now called a "Convert-a-plane." (All photographs courtesy of Aero Digest)



**THE PROGRESS OF AVIATION** is dotted with many efforts to approach vertical ascent and descent. This photograph, borrowed from the historical files of Aero Digest, shows an interesting early model.



**OPENING OF** the St. Petersburg-Tampa air boat line New Year's Day, 1914. The rigors of passenger travel at that time need hardly be emphasized by comparison with today's luxurious transports.

THE AVIATION INDUSTRY *OK's* SYNTHANE

BAKELITE-LAMINATED for

LIGHT WEIGHT with Structural Strength
LIGHT WEIGHT with Corrosion Resistance
LIGHT WEIGHT with High Dielectric Strength
LIGHT WEIGHT with Ease of Machining

# SYNTHANE TECHNICAL PLASTICS

SYNTHANE
Bakelite — Laminated

SHEETS • RODS • TUBES • FABRICATED PARTS • SILENT STABILIZED GEAR MATERIAL

*Materials to remember, specify and use for aircraft parts*

# AIR — against WATER

Rising and falling with the waves . . . men on a rubber raft . . . human lives snatched from the sea . . . by a thin layer of inflated rubber.

Important? Yes. It's important that the thin sheets of rubber be kept free of cracks and blisters, that the raft unfold easily, that it be *safe* when it's needed.

That's why rubber life rafts are processed in special air conditioned rooms . . . to make the rubber tough and long-lasting. *Room temperature and humidity are maintained more exactly than ever.*

To do jobs like this, air conditioning equipment must be more precise, more flexible, more compact. Required "climates" must be reproduced faithfully . . . wherever and whenever wanted.

General Electric has already taken an outstanding part in developing this new kind of air conditioning for war industries. After the war, *all* users of air conditioning will benefit from the lessons we have learned in meeting these stringent war requirements.

More people will enjoy air conditioning because it will be more compact . . . more economical. Cars will have it. Also planes and boats. Small stores, as well as large, will want it to increase sales, to keep goods fresh. Factories will demand it as an aid to production.

The place to turn for this new equipment will be General Electric . . . a logical source of heating, refrigeration, air conditioning, and heat transfer equipment of all kinds. Turn to G-E.

*Air Conditioning and Commerical Refrigeration Department, Division 427, General Electric Co., Bloomfield, N. J.*

*Air Conditioning by*

**GENERAL ELECTRIC**

## Plywood Structures

(*Continued from page* 149)

skin are permissible due to the increased skin thickness in the lower density material. There is not the same weight economy possible in stiffened plywood shells by close stringer spacing that is found in stiffened metal panels. In the latter material small stiffeners carry an appreciable "effective" width of skin. The interaction between plywood plates and stringers is still under investigation but indications at this time are that the applicable rules will be substantially different from those which are used in current metal practice.

Direction of grain in fuselage veneers has been largely a matter of the designer's judgment. In fuselages of large cross section and length avoidance of scarf joints in the veneers has led to the use of the face grain at 45 deg. to the thrust line. The effective modulus of elasticity varies with grain angle and is approximately 260,000 psi. for grain angles at 45 deg. A somewhat simplified design approximation of sizes is possible with this veneer arrangement since the resulting skin panel has a low modulus of elasticity resistant to stresses parallel to the thrust line. It is then not unreasonably conservative to neglect the skin and to design stringers of sufficient substance to resist the bending stresses as a first approximation. The skin is in turn designed to carry the shear. This system has been reasonably well borne out by static test.

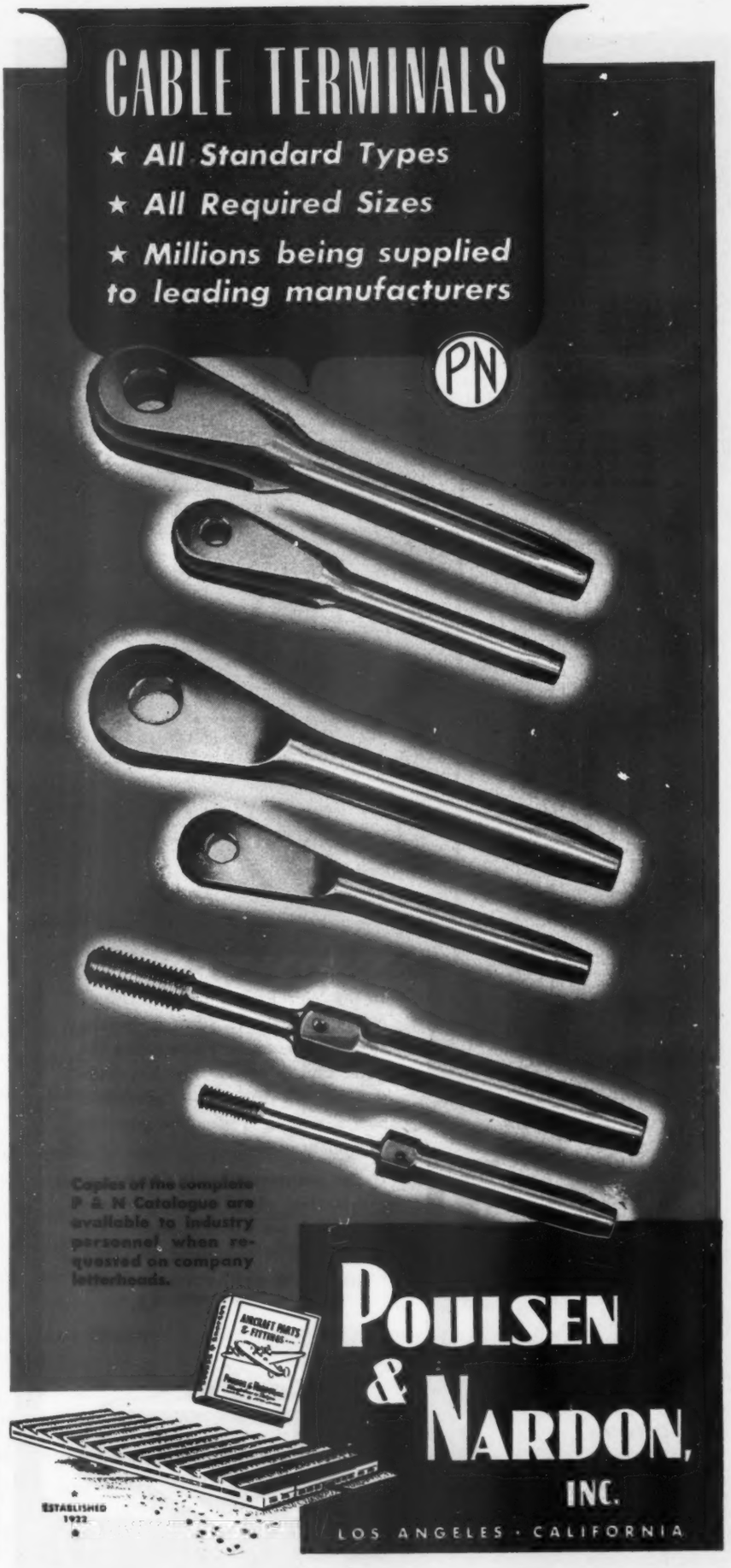
## The Old Shoe

(*Continued from page* 103)

has become world famous in the last decade, is proof of the sturdiness of this type craft.

This veteran of the sky, the original DC-2 transport, was the first of the model to be delivered to any airline. It was turned over to TWA in the spring of 1934 and had flown nearly 2,000,000 mi. as a member of TWA's fleet when it passed a stiff physical examination in 1941 and became a member of Great Britain's military supply forces. It was then as mechanically sound as the day the airline received it seven years ago.

This is a tribute to the work of airline maintenance experts. William Maxfield, our maintenance superintendent, has veteran master craftsmen at each of our principal stations. When these specialists have gone over every inch of a plane before it rolls up the runway for the takeoff, that plane is as perfect as though it just had left the assembly line at the factory where it was built.


CABLE TERMINALS
★ All Standard Types
★ All Required Sizes
★ Millions being supplied to leading manufacturers
PN
Copies of the complete P & N Catalogue are available to industry personnel when requested on company letterheads.
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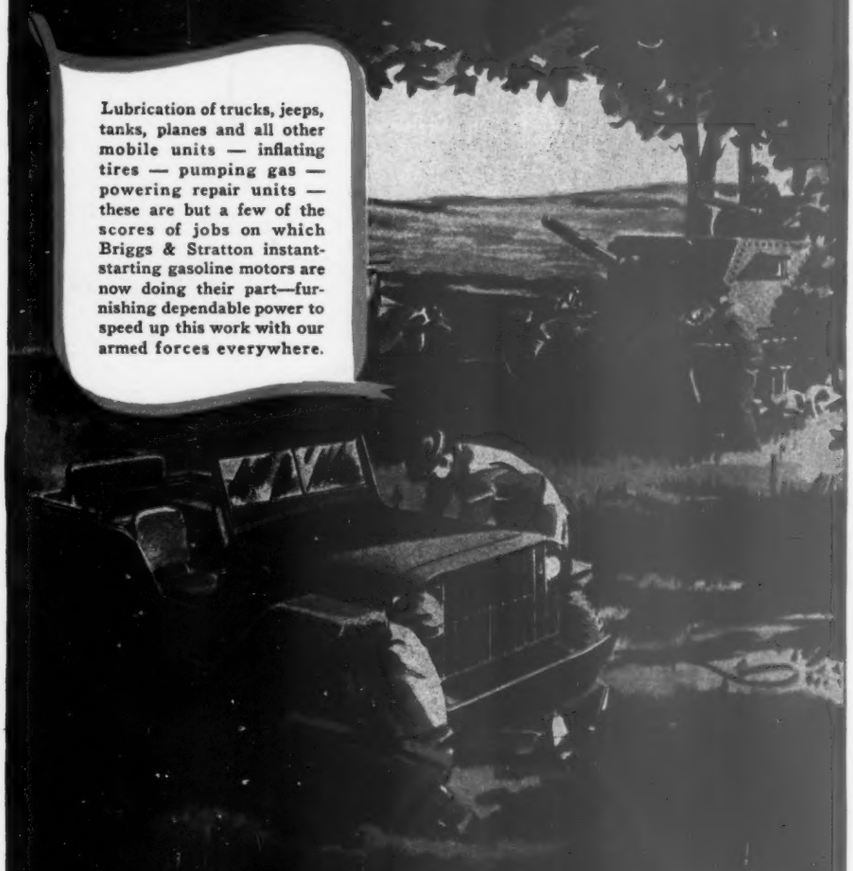
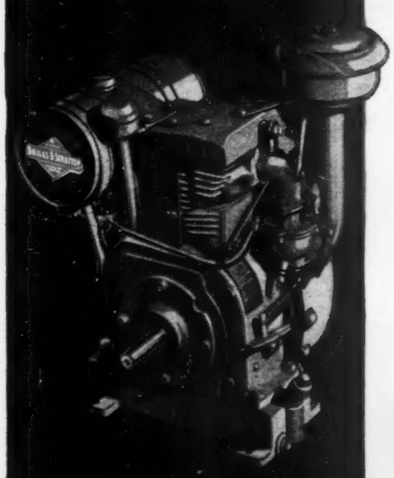
*Helping Service...*

**the Mobile Units of Our Armed Forces**



Lubrication of trucks, jeeps, tanks, planes and all other mobile units — inflating tires — pumping gas — powering repair units — these are but a few of the scores of jobs on which Briggs & Stratton instant-starting gasoline motors are now doing their part—furnishing dependable power to speed up this work with our armed forces everywhere.



In the War Program of the United Nations, Briggs & Stratton 4-cycle, air-cooled motors are now giving the same kind of service that has made them world famous — "preferred power" wherever gasoline powered equipment is used.

If you are now planning post-war production of gasoline powered equipment, we would appreciate the opportunity of consulting with you.

BRIGGS & STRATTON CORP.
MILWAUKEE, WISCONSIN, U. S. A.

ARMY E NAVY
4 CYCLE
BRIGGS & STRATTON
GASOLINE MOTORS


## Maintenance with the AVG

(*Continued from page* 106)

rounding territory. From these depots dispersal of all essential maintenance material is then made. Dispersal is all-important—but it can be overdone, and it will work effectively only when there is a good inventory and record-keeping system, so that you will always know where certain material is when it is wanted.

The dispersal system is the heart of the Chinese Army material policy, and is dictated by the necessity of hiding supplies from the "brown dwarf raiders." Secrecy is so rooted in the dispersal system that it is practically impossible for the Japanese airmen to locate it, or, for that matter, for the Chinese high command and China's Allies—to find records of the location of material once it has been dispersed, China style. It might be argued that there is no reason why the dispersal of material could not be fully recorded; but the secret dispersal system had made each unit of the Chinese Army an independent fighting unit and China's total strength an unknown quantity through more than four years of war.

I called the attention of Col. Chennault to this inefficient situation. I told him, on more than one occasion, that the aircraft material supply department was so vital to the AVG that he should take on the job of running it, as a matter of self-preservation.

"The AVG," said Chennault, "is a tactical fighting unit. As such we are interested but cannot possibly run a maintenance unit other than simple ground service operations on the field. These operations cannot exceed 15 min. in duration. If a plane cannot be prepared for flight within that quarter-hour, it should be withdrawn to a dispersal point for servicing by other maintenance personnel."

Subsequent events proved the soundness of Chennault's decision to undertake only First and Second Echelon maintenance. As to the secret Chinese dispersal system it remained, but my right-hand man, Teh Chang Koo, set up his own inventory system. He kept notes in a little book—and remembered much more in his head—which was just as well.

When we finally had things in running order our principal bases for maintenance and service were at Kunming, Loiwing and Rangoon. An important corallary to this was the establishment of satellite fields. These may best be described as small, well-camouflaged fields not too distant from the principal bases and accessible by a system of communications. Satellite fields are invaluable, when a main base is

(*Turn to page* 319)

# 30 Ounce Miracle
## *that Revolutionizes Starting Ignition*

"MIRACLE?" Well, miraculous at least for the way it is strengthening American air might in the frozen wastes that may become the main thoroughfare of this global war.

For as aviation engines have constantly grown in size and power, one major difficulty has been the problem of providing adequate all-climate starting ignition.

Today this problem has been solved by the American Bosch Induction Vibrator . . . a simple device small enough to put in one's pocket. From the Equator to the Poles—winter or summer—engines in United Nations planes can now start in a flash and get into the air more quickly.

This development—begun in times of peace under the American Bosch policy of relentless research in every phase of its field—has been completed in time to meet intensified military demand. Broadening the potential battle zone of every plane in which it is installed, it serves the cause of Victory by helping to open new fronts for American and Allied air strategy.

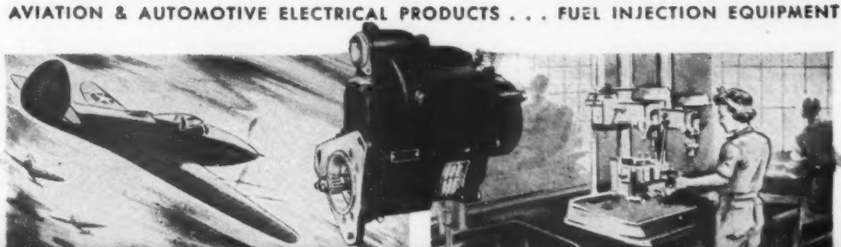
★ ★ ★

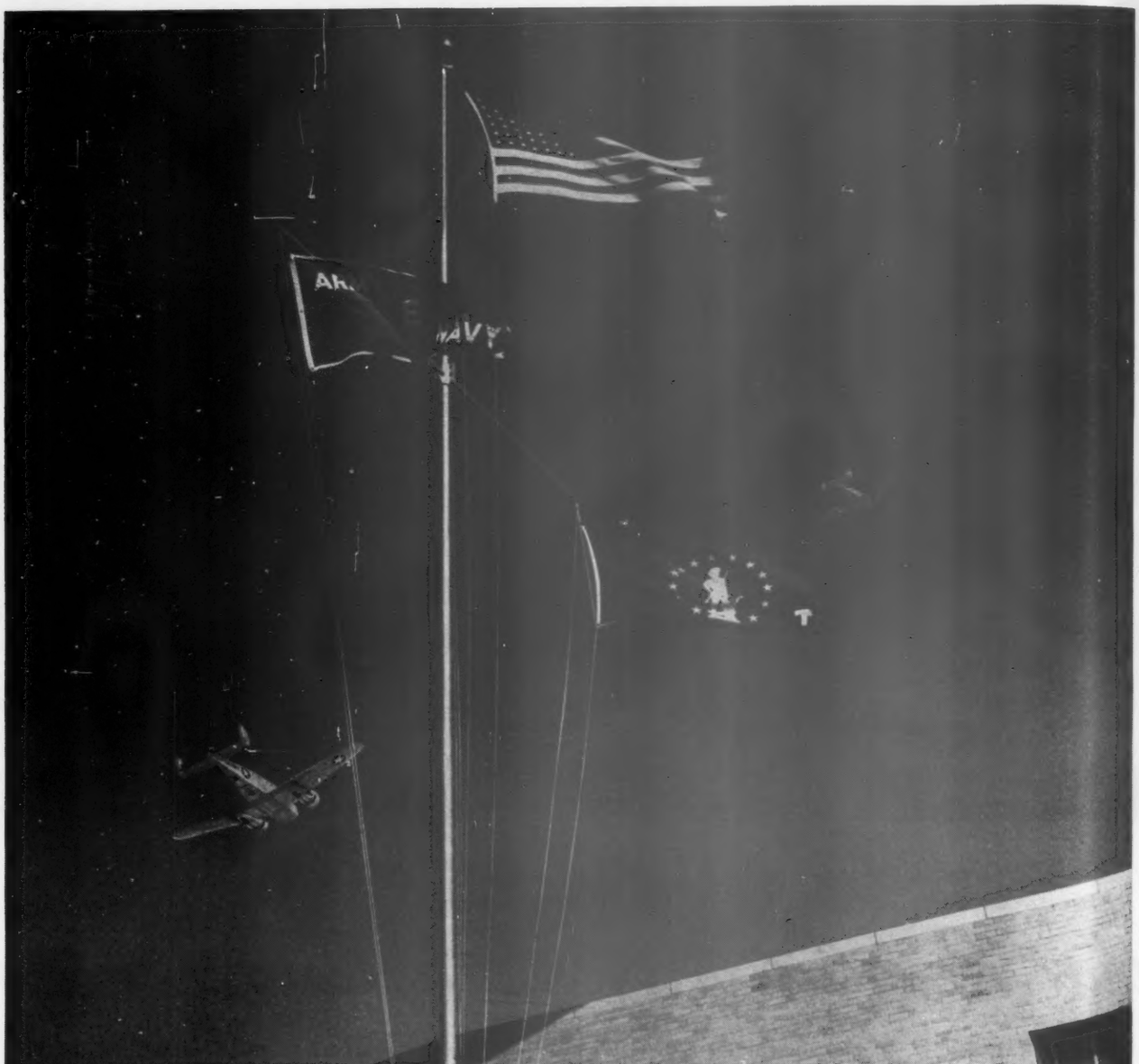
*American Bosch Corporation • Springfield, Mass.*

*Craftsmen in the New England Tradition*

# ★ AMERICAN BOSCH ★

AVIATION & AUTOMOTIVE ELECTRICAL PRODUCTS . . . FUEL INJECTION EQUIPMENT





*Symbols*

**Beechcrafters are doing their part; and these are the symbols of their devotion**

Beech Aircraft

CORPORATION

*BEECHCRAFTS ARE DOING THEIR PART* *WICHITA, KANSAS, U.S.A.*

(*Continued from page* 316)

bombed out and emergency landing and service ports are needed. It was the lack of satellite fields which finally made our Magwe, Burma, base untenable. But satellite fields are not of much value unless you can camouflage them for safe dispersal of planes.

### Importance of Mobility

The first all-out bombing of Rangoon on Dec. 23, 1941, taught us many valuable lessons, not the least of which was the need of a high degree of mobility for all service and maintenance units. Seeing this lesson clearly in the rubble dust of our Rangoon base, Squadron Leader John Newkirk and Crew Chief Fox called a meeting. I was delegated to appeal for help from Lieut.-Col. R. J. Twitty, commanding officer of the American Military Mission in Rangoon. I told him that without vehicles our ground force was unable to protect its materials, and the AVG, which was already showing its mettle, would be out of the war. With the colonel's help, we eventually rounded up, from British, Chinese and other sources, four Chevrolet Command cars, six GMC 6x6 trucks, six Studebaker and Chevrolet tank trucks, complete with pumps and equipment for refueling planes, and six jeeps.

We used the 6x6 trucks for handling communications, tools, parts and other things of that type, as well as for transporting members of the ground crew.

The motorization which resulted from this move was our salvation. When the air alarms sounded all planes, on the alert and ready under Chennaults 15-min. rule, took off. While the planes were still circling for altitude, the ground crew was already busy loading all materials on the field for operations on the trucks, which they then drove hell for leather to previously designated dispersal points.

In most instances, the squadrons took off within 2 min., while the ground crews cleared the field in approximately 3. Any plane, incapable of flight, was dispersed along with the trucks. If the Japs succeeded in coming over all that they found was a bare field and whatever buildings had not been bombed out previously. With the Flying Tigers on their tails, it was impossible for the Japs to hunt out the evacuated trucks and strafe them. No one in the ground crew ever got hurt after this system was put in operation.

As soon as the raid was over we would be back on the field, preparing for the landing of our P-40's. Often we would have to fill in bomb craters to get the fields in shape—but at least we were there to do it.

This experience proves to my com-

Christmas Greetings

FROM

The Employees

OF

The Pressed Steel Co.

THE MARK OF QUALITY

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of WILKES-BARRE, PENNSYLVANIA

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DETROIT: 312 Curtis Building • TOLEDO: 1914 Vermont Avenue

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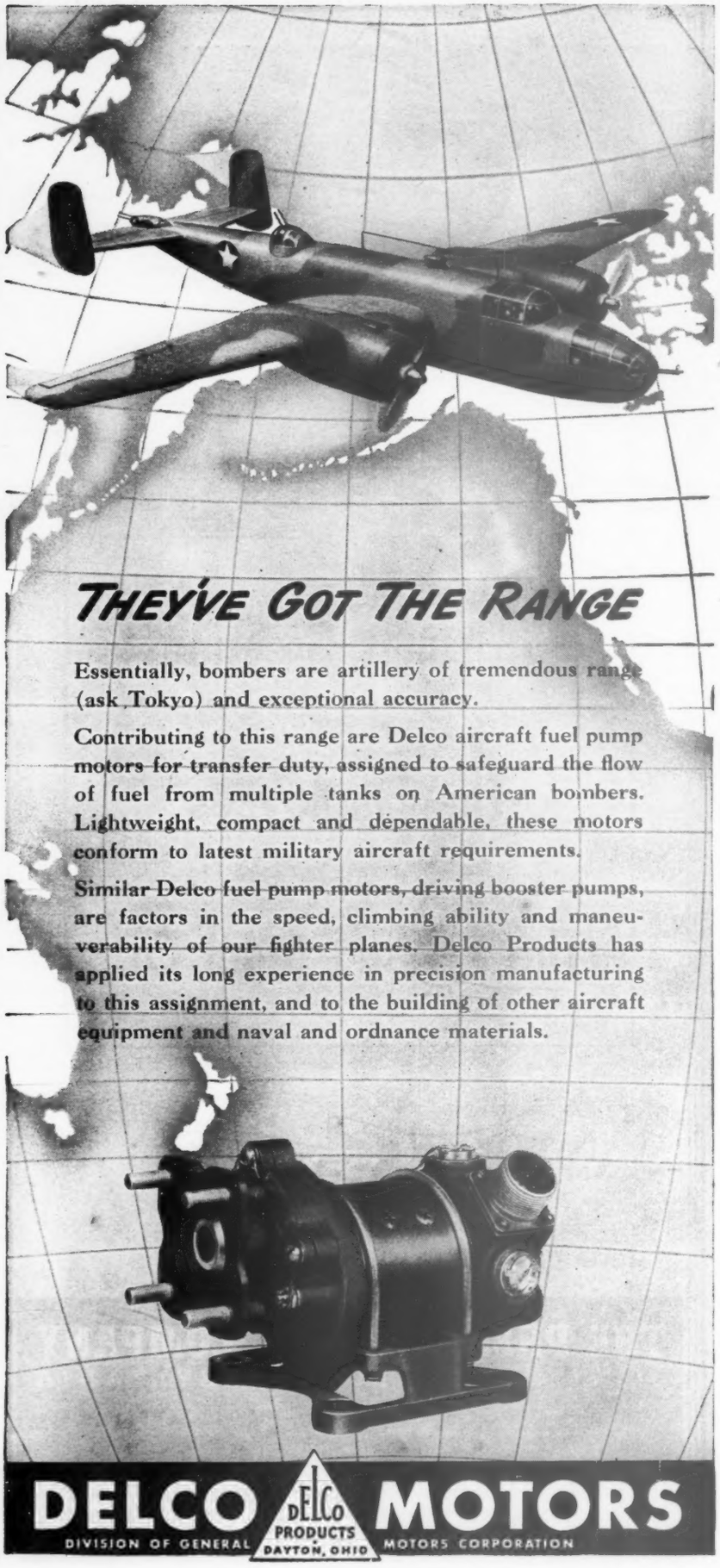
**PRESSED STEEL COMPANY PRODUCTS:** Carburizing and Annealing Boxes. Thermocouple Protection Tubes. Seamless Steel Cylinder Caps. Seamless Steel Neck Rings. Welded Alloy Tubing for High Temperature and Corrosive Application


THEY'VE GOT THE RANGE
Essentially, bombers are artillery of tremendous range (ask Tokyo) and exceptional accuracy.
Contributing to this range are Delco aircraft fuel pump motors for transfer duty, assigned to safeguard the flow of fuel from multiple tanks on American bombers. Lightweight, compact and dependable, these motors conform to latest military aircraft requirements.
Similar Delco fuel pump motors, driving booster pumps, are factors in the speed, climbing ability and maneuverability of our fighter planes. Delco Products has applied its long experience in precision manufacturing to this assignment, and to the building of other aircraft equipment and naval and ordnance materials.
DELCO MOTORS
DELCO PRODUCTS
DIVISION OF GENERAL MOTORS CORPORATION
DAYTON, OHIO

plete satisfaction that complete motorization of the ground service organization is as important to the success of a combat unit as its planes, when the unit is located within the bombing range of the enemy. In bases so situated, we should forget about hangars and permanent structures of all sorts. Your base is the first objective of the enemy, and you are bound to be hit there sooner or later. The answer is vehicles to move your ground service crew to hidden dispersal places during the attack.

### Communications

Finally and of almost equal importance to effective and successful servicing and maintenance in the field is communications. Auxiliary communications are vital, during air action, to not only the base field but to the so-called satellite fields. When this goes, as happened in the case of the big December bombing on the Rangoon base, it not only imposes an enormous handicap in the successful conclusion of the actual aerial battle, but it prevents ground service from being prepared to perform properly its duty at the conclusion of the battle. When the smoke cleared after the Rangoon attack it was discovered among other things that our one radio set was out of action. No arrangement had been made for an emergency hook-up to the field. To all intents and purposes we were isolated from the outside world. We finally solved the situation by running emergency telephone lines from the main base hangar to the alert tent at the dispersal base; and we never forgot the final lesson which pointed the need for auxiliary emergency communications means to all of the principal points of our operations.

## P-40's in Burma

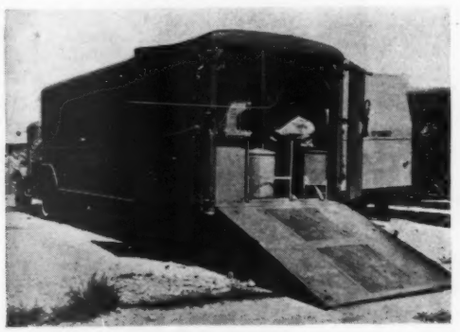
(*Continued from page* 101)

tected airplanes caused the metal to get so hot that the workman could not touch them. This necessitated the construction of about eight mat sheds in the flight test area under which the airplanes could be placed when it was necessary to work on them (Fig. 9). A small hangar, accommodating two airplanes, was constructed in the flight test area and it was used for working on those airplanes where the cowling had to be removed and the airplane had to stand exposed for several days. (Fig. 10.) The airport was of ample size and was used by the Royal Air Force as a base for their operations. The north-south runway was 3,000 ft. long and the east-west and the northwest-southeast runways were each 2,500 ft. long.

(*Turn to page* 323)

# DoAll at Ryan

Left—View of DoAll at work making blanking dies in the Ryan plant. A great deal of time is saved because it is not necessary to drill holes around the die outline and laboriously file to the final contour.



## REPAIR SHOP ON WHEELS

Illustrated is the exterior of one of the U. S. Air Corps mobile machine shops used for repairing damaged planes right on the spot. The DoAll is part of the equipment of each unit.

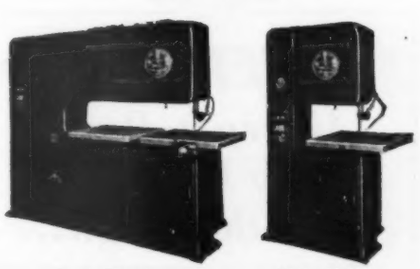
# THE TIME STRETCHER

Wherever parts are made, planes assembled or repaired, DoAll is doing a Herculean ob. Search the world over and you'll never find a machine to beat the DoAll when it omes to versatility and speed in precision cutting of aluminum, magnesium, synthane, asonite, plymetal, stainless steels, plastics, wood, etc.

- Cuts thick sections of any metal or material.
- Does both internal and external cutting, following a hairline outline.
- Cuts so clean, further machining is unnecessary.
- Relieves miller, shaper and lathe of hundreds of over-load jobs.
- * Eliminates bottlenecks on regular production lines.
- * Avoids shut downs of important machines by actually making new replacement parts.
- * Makes special tools without dies or molds.
- * Saves hundreds of man hours—tons of metal.

**The EXACT SIZE for Every Department**

**All Models with Motors**



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A factory trained man will call with a DoAll and show you how this wonder machine will aid in getting your jobs out ahead of schedule. EASY READING—"DoAll on Production", an illustrated book you'll want to send for today.

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## FLEETWINGS

## *Aircraft Parts Help Re-paint Another Sign...*

**NINE months ago, as an indication of the spirit with which Fleetwings' men and women were turning out increased quantities of aircraft parts, the company re-painted its "Defense Plant" signs . . . changed their wording to "*Attack* Plant."**

**Today, the total of Fleetwings parts rolling off our assembly lines is greater than ever! And Fleetwings parts... wings, flaps, stabilizers, ailerons, fuselage sections, hydraulic equipment . . . incorporated into American fighting 'planes, are helping to turn the "No Man's Land" on the air-fronts into "U. S. Territory."**

**Of course, today's vast production at Fleetwings is all earmarked for war. But for peace, Fleetwings' engineers already have plans on the drafting boards. With Victory they will grow and shape themselves to help fly America to her ultimate destiny in the skies.**

★

**FLEETWINGS**

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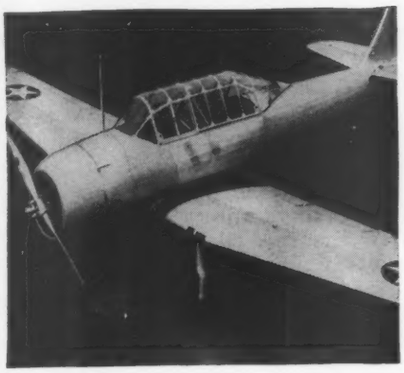
**BRISTOL • PENNSYLVANIA**

FLEETWINGS

*pioneers with parts and hydraulic equipment*



*The BT-12, all-welded basic trainer built for the U. S. Army Air Forces.*

**CREDIT FOR THE FIRST** all-welded military 'plane constructed principally of stainless steel goes to Fleetwings for the BT-12. A fleet of these sturdy, airworthy basic trainers is now a-building at Fleetwings for the U. S. Army Air Forces.

**THE GROUP** of time-saving production tools designed by Fleetwings' employees continues to grow each month. Newest of these tools is an electric "mouse," an intriguing little device to aid loftsmen in drawing extra long straight lines. The "mouse" improves accuracy and greatly reduces drawing time.

**ONE OF THE REASONS** for the outstanding "in-service" record of Fleetwings-designed hydraulic equipment lies in the grueling testing each hydraulic valve and jack must undergo before it leaves our plants. Valves, for example, undergo proof tests, body pressure tests, heat and cold tests, and torque tests in addition to a check on dimensions which rejects variations greater than two one-hundred-thousandths of an inch. Fleetwings hydraulic equipment is designed for use on U. S. 'planes to actuate retractable landing gear, bomb doors, wing flaps, etc.

**SAVING SIZABLE** sheet-metal remnants and using them systematically for forming small-assembly pieces is another measure that Fleetwings has originated to help win the "War on Waste." Time, money, and effort—all are saved by this unique, sound system.

*"KEEP 'EM FLYING!"*

FLEETWINGS

*Incorporated*

BRISTOL • PENNSYLVANIA

(*Continued from page* 320)

The runways had a crushed rock base with a rolled gravel surface. It was usable in all kinds of weather but the loose gravel was easily picked up by the propellers, and was a source of constant annoyance. The approaches to the runway were only fair as there were trees on all sides except to the south.

As soon as the airplanes were flight tested and all necessary adjustments were made, the headquarters of the American Volunteer Group located at Toungoo, Burma, were notified and they sent pilots down to take delivery and ferry them from Rangoon to Toungoo. The last airplane was delivered on Nov. 26, 1941, and the American Volunteer Group pilots got their first taste of action along the Burma Road on Dec. 20, 1941.

## America at War

(*Continued from page* 95)

home. A swarm of barnyard chickens is no match for a fighting cock. The thing to look for is victories against the enemy, destruction of his ships and his military and manufacturing works.

The air cargo program has been increased again. There is no official information on the extent of the increase, however. The plan a few months back was to turn out hundreds. There are no exciting new planes in the cargo class for the immediate future, although several very big ones are nearing the experimental stage. Mostly, they are the tested types everyone knows about.

Most interesting recent development in cargo is an order placed by the Army for the production of 1,200 wood cargo planes by Andrew J. Higgins, the New Orleans builder of combat boats. The Higgins plane is not a new design; it is the Curtiss-Wright C-76, plywood, two-engine transport, roughly the size of the Douglas DC-3. Curtiss-Wright has already tested this plane, and it has been accepted by the Army.

With many aircraft plants slowed down for lack of materials, it is easy to wonder why an order is given to still another plant, which has no airplane experience. There are many partial answers, and one of them is salesmanship. Higgins is a man of imagination and audacity who believes he can do most anything he tries. It was he who devised an assembly line for the construction of Liberty ships, and sold it to the Maritime Commission. It probably would have worked, but there wasn't enough steel plate, and the project was stopped. Higgins has been building torpedo and other kinds of attack boats for the Navy, out of plywood. He makes them so tough they can be run onto a stony beach full tilt without breaking up. He amazed the Navy by building a troop-landing boat that slithers right out on land. It was probably the President himself who let Higgins have the order. Mr. Roosevelt inspected Higgins' abandoned assembly-line shipyard; he looked at a sample of Higgins' basket-weave plywood. F.D.R. likes people who are not afflicted with inferiority complexes.

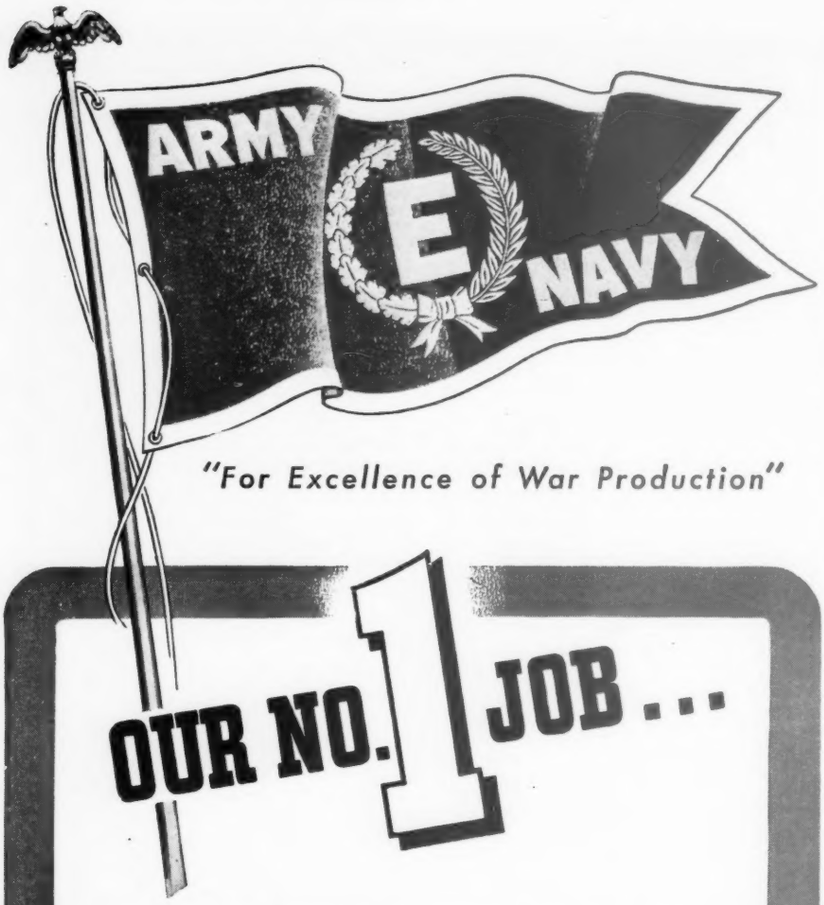
A few notes to add to background: The B-17 has been bombing and strafing from mast-top levels, though it was originally a high altitude bomber. We are finding out that hitting ships from high up is very difficult, because they are learning to turn while the bomb is falling . . . New Zealand's Army is under United States command and its flyers are fighting with United States forces in the Solomons . . . The biggest aircraft assembly base on any front is in Africa; British and American planes stream out of it to Near East bases . . . Russia does not believe that air power alone can win the war, and is very critical of British and American hopes to avoid ground battle by destruction of Germany from overhead . . . One of the biggest surprises in recent air war was Britain's big *Lancaster* bomber raid on Europe in broad daylight without losses; that was supposed to be exclusive for B-17's and B-24's . . . Biggest loss of the B-17's in Europe so far was three in one day . . . 1,000 Axis planes have left their skeletons on Malta's rocks and in adjacent waters . . . Counting up the wood airplanes now in the war—trainers, transports, Britain's *Mosquito,* its half-wood *Hurricane,* Russia's first-line wood fighters, and the prospect of a wood *Spitfire*—one begins to wonder what we are going to do with all that aluminum our plants will turn out next year.

## Field Experience Back to Plant

(*Continued from page* 125)

representatives must play an important part in seeing that the damaged aircraft are properly repaired, such knowledge is constantly drawn upon.

After a man is selected he is given a comprehensive, special training course at the plant which lasts from ten to twelve weeks. Upon graduation he is given a domestic assignment as a junior service representative, and works under the guidance of a senior service man. It generally takes six months' experience as a domestic service man before we feel he is qualified to accept a foreign assignment. Work in foreign fields requires considerable initiative, as in many cases the equipment with which work has to be done is limited




"For Excellence of War Production"

OUR NO. 1 JOB . . .

The Army-Navy "E" burgee that flies over the Packard Electric factory means more to us than an award for work well done. It is a constant reminder of the work that lies ahead . . . building more and more equipment to meet the requirements of America's planes, tanks, trucks and military vehicles of all kinds. No other considerations, no obstacles, can stand in the way of this vital assignment. It is our No. 1 job, and we will see it through. Packard Electric Division, General Motors Corporation, Warren, Ohio.

Packard
REG. U.S. PAT. OFF.
TRADE MARK

"Working for Victory"

THE STANDARD WIRING EQUIPMENT OF THE AUTOMOTIVE INDUSTRY

and has to be adapted, or is nonexistent and has to be created.

We have formed a unique organization known as the "Certified Service Representatives League," to which all field service representatives are admitted upon graduation from the factory school. In order to continue membership after they have proceeded to various parts of the world, however, each must answer a series of questions which are drawn up every month and which must be completed and returned to the home office. In this manner the home office is able to keep a close check on the ability of field representatives to handle the jobs assigned to them.

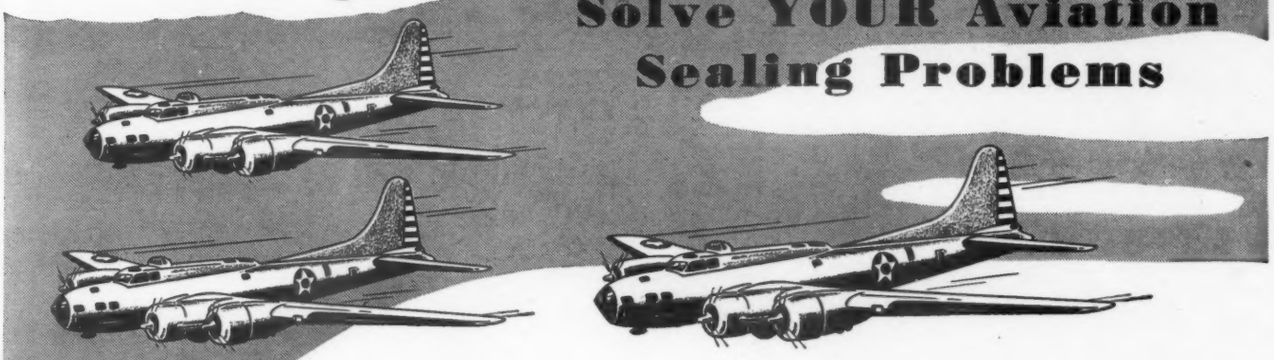
Each field representative returns to the home office every six months for the purpose of making first hand reports, polishing up on new developments, and discussing possible new assignments. These face-to-face discussions of problems encountered fill in much between-the-lines information of their written reports, and add to the knowledge of both the field men and the home office. Because we cannot afford to entrust critical work to men who dislike their jobs, we insist that each field man renew his contract, so to speak, for field assignment every six months. This provides a routine avenue of escape from unpleasant work for those who do not like such work, and assures our armed forces that only competent, up-to-the-minute, enthusiastic field representatives are on the ground, forming a connecting link between operations and manufacturing.

North American's educational program, which is conducted at the plant for the Army Air Forces officers and enlisted men who will maintain and repair B-25 *Mitchell* bombers in the field, is also an important part of our efforts to keep the equipment in working condition at the several fighting fronts. Each month hundreds of men, most of whom are graduates of the Army basic mechanics schools, are sent here for specialized training. Experts from the factory serve as instructors, meeting classes that are operated on a 24-hour-a-day basis. Motion pictures, slides, demonstration boards, and actual airplanes are used to train these men. When they complete the courses they are thoroughly familiar with our airplanes and are able to properly diagnose any mechanical trouble and know how to correct it.

A plan is now under consideration to assign each graduate of this school to a specific airplane during its final stages of construction in order that he might travel with the plane when it is delivered, and stay with it as long as it is in use. In this way each mechanic will look upon the airplane as his own

(*Turn to page* 327)

# Let PRESSTITE *Aircraft* SEALING COMPOUNDS Solve YOUR Aviation Sealing Problems



Since their introduction to the aviation industry a short time ago, Presstite Aircraft Sealing Compounds have won wide acceptance by the aircraft manufacturers of America.

Especially developed for your industry—engineered to solve many of your problems—these Presstite Compounds provide fast, simple and long-lasting methods of sealing a wide variety of aircraft joints—especially in aviation *fuel tanks*. Their ease of application speeds production—proven adhesive qualities reduce maintenance, assure satisfactory sealing under all conditions.

All Presstite Sealing Compounds are available for immediate shipment.

*No. 2D-126A Permagum*

A non-corrosive, non-drying, non-hygroscopic, non-polymerizing, permanently elastic, rubber-like material used as a plugging or sealing material to seal larger openings in corners or seams of fuel tanks. Not soluble in Aromatic Fuel.

*Plywood Fuel Tank Sealer*

For sealing light-weight plywood and plastic auxiliary airplane fuel tanks. Brush—spray, or slush type—resists aromatic fuels.

*Extruded Fuel and Oil Tank Sealers*

Easy to handle because in extruded form on cloth backing—varied widths and thicknesses. Highly adhesive to metal surfaces even in presence of liquid hydrocarbon. Non-oxidizing, non-polymerizing, resists aromatic fuels.

*Extruded Sealer for Synthetic Glass*

Seals joints in aluminum as well as synthetic glass—especially designed for windshields, windows and gun turrets. Stands up under extreme low temperatures. Seals joints tight against water, air, aircraft fuel, motor oil. Permanently elastic.

*Fuel Tank Sealer*

Brush-on type for sealing integral tanks and for seams and joints in bolted tanks used for aromatic fuel storage. Will not slump up to plus 200° F., remains flexible at minus 90° F.

*Cabin Sealer*

For sealing over riveted joints in pressurized high altitude ships. Provides water and air-tight seal—withstands temperatures from minus 90° F. to plus 212° F.

*Zinc Chromate Compound*

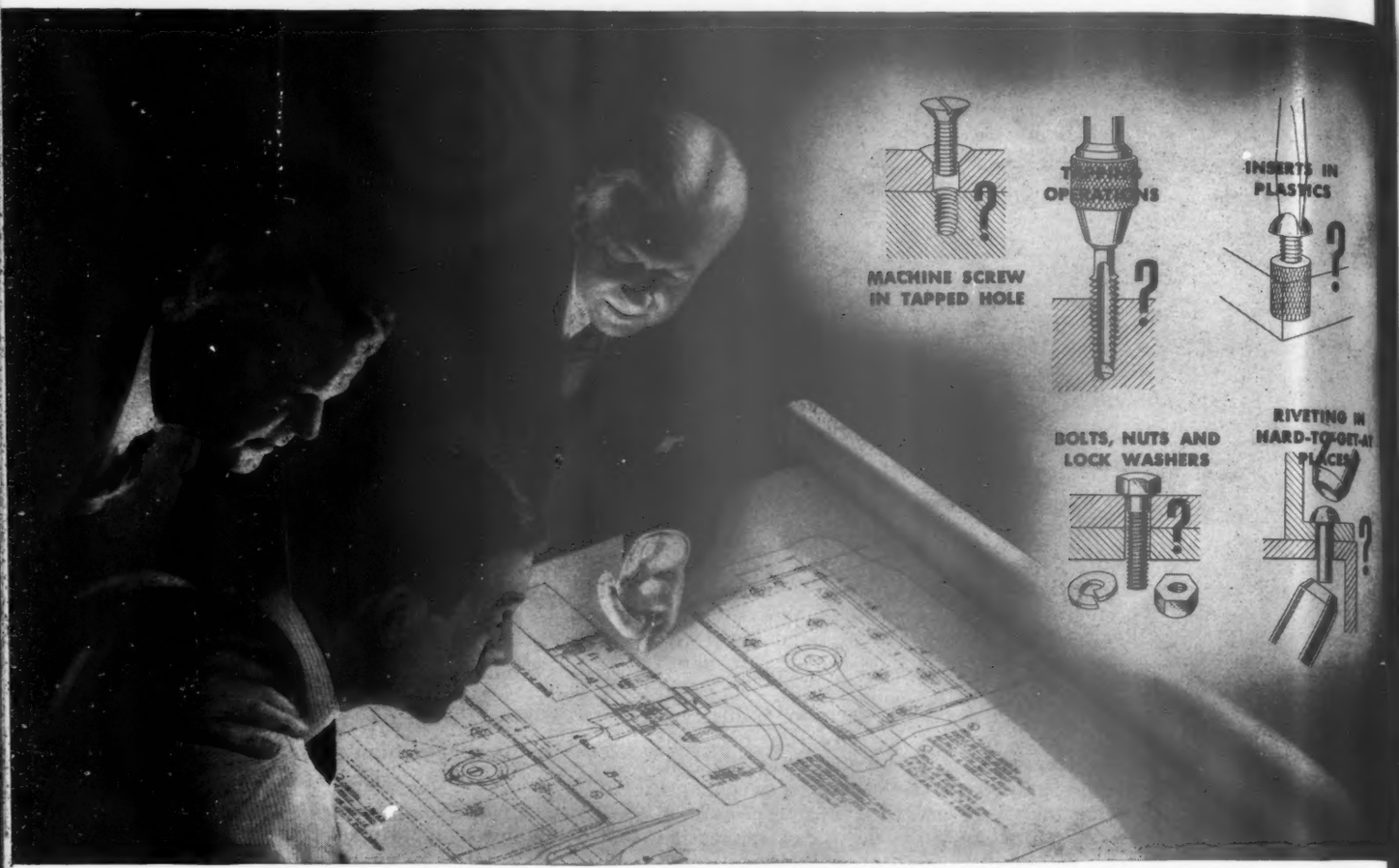
For Conditions A and B, Air Corps Spec. No. 3596, and Slushing Compound Air Corps Spec. No. 3595.

Let Presstite engineers help you to solve any sealing problem in your industry. Send us complete detailed information on your needs and specifications today.

PRESSTITE SEALING COMPOUNDS

**PRESSTITE ENGINEERING COMPANY • 3910 Chouteau Ave., St. Louis, Mo.**

# *Question* every fastening job..




## *Wherever You Can Use P-K Self-tapping Screws You Can Save Time-Consuming Operations!*

It has never been claimed that Parker-Kalon Self-tapping Screws offer the best means of making EVERY fastening under ALL conditions . . . BUT, it is a fact that, *for a very large percentage of metal and plastic fastening jobs, these famous screws offer a combination of ease, speed and security that no other fastening device or method can match!*

### *How P-K Self-tapping Screws Simplify Fastening Jobs . . .*

One easy operation makes a fastening with P-K Self-tapping Screws . . . merely drive the Screws into plain untapped holes. Such simplicity eliminates tapping and tap maintenance . . . solves the problem of getting scarce taps . . . stops fumbling with bolts and nuts and placing of lock washers . . . does away with inserts in plastics . . . cuts out riveting and welding in hard-to-get-at places.

Start now . . . *question* every fastening! Be sure you can't employ the simple Self-tapping Screw method before you put up with a more difficult one.

SELF-TAPPING SCREWS FOR EVERY METAL AND PLASTIC ASSEMBLY

*Call in a P-K Assembly Engineer to check over fastening jobs with you.* He can show you how to search out ALL opportunities to apply P-K Self-tapping Screws. And, he'll recommend them only when they will do the job better and faster. If you prefer, mail in assembly details for recommendations.

### *Change to Self-tapping Screws Over Night...*

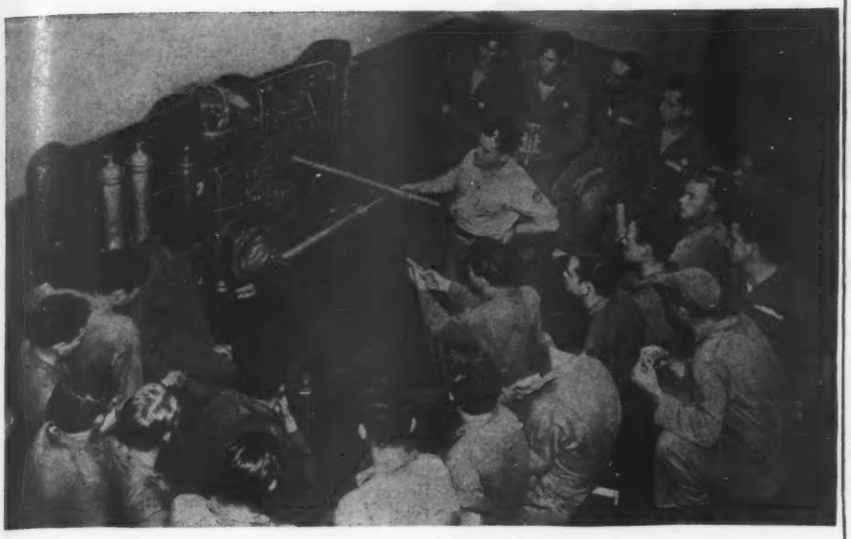
No matter what material you're working with... light or heavy steel, cast iron, aluminum, brass, plastics . . . you can adopt P-K Self-tapping Screws to advantage. And you can make the change-over without interrupting production. No special tools or skilled help are required. Parker-Kalon Corp., 192 Varick Street, New York, N. Y.

**PARKER-KALON**

*Quality-Controlled*

**SELF-TAPPING SCREWS**

Give the Green Light to War Assemblies



*Field maintenance begins at the plant where North American experts train United States Army Air Forces ground crews to service and repair the planes it makes. In this photo a class is shown studying the hydraulic system of a B-25 "Mitchell" bomber.*

(*Continued from page* 324)

and take special pride in keeping it in perfect condition.

The third phase of our field service embraces preparation and distribution of technical manuals. These are prepared and kept up to date for the field men from material developed as a result of the reports they send or bring in to the home office. As soon as a problem is encountered and its solution has been worked out, the data is prepared for the manuals and placed in the hands of those who will need it.

In addition to the men actively engaged in the service work, there is a group of men who see little of the airplanes in action, but who, through long hours of ceaseless effort, support those on the fronts—the men in the service office at the home plant. These are the men who study and analyze the field representatives' reports, find the answers to the problems thus uncovered, and get the results to the proper place, whether it be the drafting board, the production lines, or some point hitherto unheard of on the other side of an ocean.

Members of this latter group publish a weekly service newspaper the purpose of which is to keep service representatives informed of all design changes, new methods of repair, and all other information of value that is learned as a result of actual operational experience. Some prepare service bulletins, complete with drawings, which outline changes scheduled for the aircraft in service. Others compile records of service failures, reports on consumption of parts, and also process the shipment of service parts. And, finally, there are men who study and answer the almost countless letters and reports received from North American field representatives, from the Army Air Forces, and from military officials of those countries who together with the United States comprise the United Nations.

## Heat-Treating

(*Continued from page* 173)

about a foot in length are quenched in a special rotating fixture and are carried through the quench automatically after handling. Parts which do not require special handling to prevent warpage are discharged directly into the quench when the hearth of the furnace is tilted. These furnaces, with all others used, are equipped with automatic thermostatic control for maintaining the temperature set with the particular part being handled. Parts which require cyaniding are handled through an Ajax salt bath furnace equipped with electrodes for heating. A water tank at one side and an oil tank at the other side of the furnace are arranged so that either may be used for quenching. Parts handled through this furnace are heated to about 1,500 deg. F.

Most parts which are hardened naturally have to be passed through draw furnaces of which six of the gas-heated Lindberg type are provided. Parts to be placed in these furnaces are put through a trichlorethylene degreaser after oil quenching and are loaded into trays and baskets handled by a one-ton overhead bridge crane. Products of combustion provide a reducing temperature and are continuously circulated through the baskets of parts. Drawing temperatures range from 300 to 1,200


A COMPLETE LINE OF AVIATION WIRE and CABLE by Wiry Joe

Wiry Joe, long a leading manufacturer of replacement wire and cable for the automotive industry, is also an important source of supply for electric wire and cable for the aviation industry.

The Wiry Joe "Aviation" line covers every need—starter cable, high-tension cable, primary cable—original or replacement. Wiry Joe also manufactures welding cable.

Every Wiry Joe "Aviation" cable is a quality cable, built to meet army and navy specifications, and produced under the Dostam Method of manufacture for high efficiency, long life, dependability and uniformity.

Inquiries concerning wire or cable for any type of service will be promptly answered.

Wiry Joe

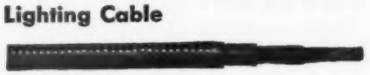
AVIATION CABLE

*manufactured by*

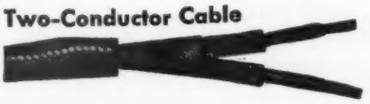
THE CRESCENT COMPANY

Pawtucket, Rhode Island

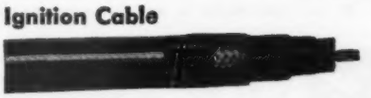
Lighting Cable



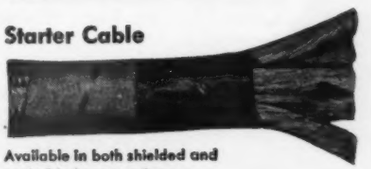
Two-Conductor Cable



Ignition Cable



Starter Cable



Available in both shielded and unshielded constructions

# HOLOPHANE

*The Most Respected Name in Lighting – Since 1898*

**Under the pressure of emergencies and in the pinch of material shortages it is wise to remember that basic fundamentals as applied to lighting do *not* change . . . Control of light to provide proper visual conditions is as dependent on scientific planning today, as ever . . . And today, as ever, Holophane continues to operate on the principle that good lighting begins with good engineering . . .**

**TODAY—Wartime Performance . . .** With 85% of all productive effort directly relying upon sight, the value of scientific lighting becomes a matter of national importance. It is significant that Holophane equipment is being installed in an ever-increasing number of important military, naval and ordnance projects.

**YESTERDAY—Scientific Principles Tested . . .** For more than two generations, Holophane engineers have contributed many major improvements in lighting technique. Mass production and intensive specialization brought the development of many new Holophane lighting units, each designed for its specific commercial, professional or technical usage. These units are serving efficiently, economically in every phase of our national life—in schools, factories and hospitals, on highways and airports . . .

**TOMORROW—Research Based on Experience . . .** Since the basic structural element of Holophane units is clear prismatic glass, their manufacture requires a minimum of critical materials. This fact, along with the constant research for new equipment promises an even more vital part, in the war program, for Holophane Planned Lighting. It saves materials, electric current and manpower. It converts waste into weapons. Its future is inalienably associated with the effort for victory.

**We have contributed to and are cooperating with the War Production Fund to Conserve Manpower**

*Holophane Engineering Service offers, without charge, consultation and recommendations as to the safest, most effective, most economical illumination of your premises . . . Write for the latest Holophane Bulletin "Lighting for War Industry"*

**HOLOPHANE CO., INC.**
342 MADISON AVENUE, NEW YORK
HOLOPHANE CO., LTD., 385 YONGE STREET, TORONTO, CANADA


deg. F. depending upon the parts treated. Time of drawing is also varied with the parts treated.

Cylinder liners are among the most important parts heat-treated. They are made from seamless steel tubing and, after undergoing rough machining, are given a stress release by heating for two hours at 1,200 deg. F. in the draw furnaces, after which they receive further machining before hardening, which takes place in 16 six-minute pushes through the whole cross furnace, during which they reach a temperature of 1,525 deg. F. before being quenched. After degreasing the liners are drawn at 900 deg. F. for two hours and are then cooled in air before they receive final machining.

Crankshafts, made from a special nitriding steel, are handled in a separate area of the department. After rough machining, the forgings undergo a stress relief during which they are heated in a special furnace for five hours at 1,100 deg. F. and then cooled in air. After further machining, within 0.020 in. of finished size, the crankshafts are given a second stress relief for the same time and at the same temperature. Then the shafts are ground and polished all over and the flange is nickel plated before nitriding takes place.

There are six Westinghouse nitriding furnaces, each capable of taking 20 crankshafts, which are carefully loaded in five tiers on a special rack along with a test piece cut from each forging. When ready for nitriding, bells to cover the charge are lowered and heating in an atmosphere of ammonia gas takes place. A temperature of 900 deg. F. is held for 65 hours after which the charge is cooled in the furnace to 250 deg. F., the total cycle requiring 84 hours.

Other large forgings besides the crankshaft are given hardness tests on 100 percent of the pieces, and the same applies to smaller forgings and to many carburized parts. Some 20 percent of other parts which have undergone heat-treatment are similarly tested. Rockwell tests are made on the smaller parts and Brinell tests on the larger ones. Before inspection, some parts are cleaned with cast iron or steel grits in a Wheelabrator, if any light scale or carbon deposits are in evidence. Parts which have been carburized have at least one piece from each bath ground and checked for thickness of case before the parts are unloaded and released by the carburizing department.

All aluminum cylinder heads and cylinder blocks are put through a furnace in which they are subjected to stress relief by heating for two hours at 350 deg. F. The Ross furnace is a continuous type fired with natural gas and

(*Turn to page* 331)

# Infinite Positions

## WITH NEW SELF-ADJUSTING PEC JIG CLAMPS

15°
15°
This exclusive PEC aperture (available on many other types of PEC clamps) allows infinite adjustments from 15° above or below horizontal.

No other clamp is as flexible in its applications . . . in closed position, the clamping bar has infinite adjustment up to 15° below and above horizontal . . . yet you can't shake open the new PEC drop forged jig clamp. Because of the exclusive PEC self-adjusting feature (which operates like the slotted aperture on a pair of pliers) it is now possible to carry a much smaller stock, as one PEC is adjustable to do the work of many ordinary non-adjustable jig clamps.

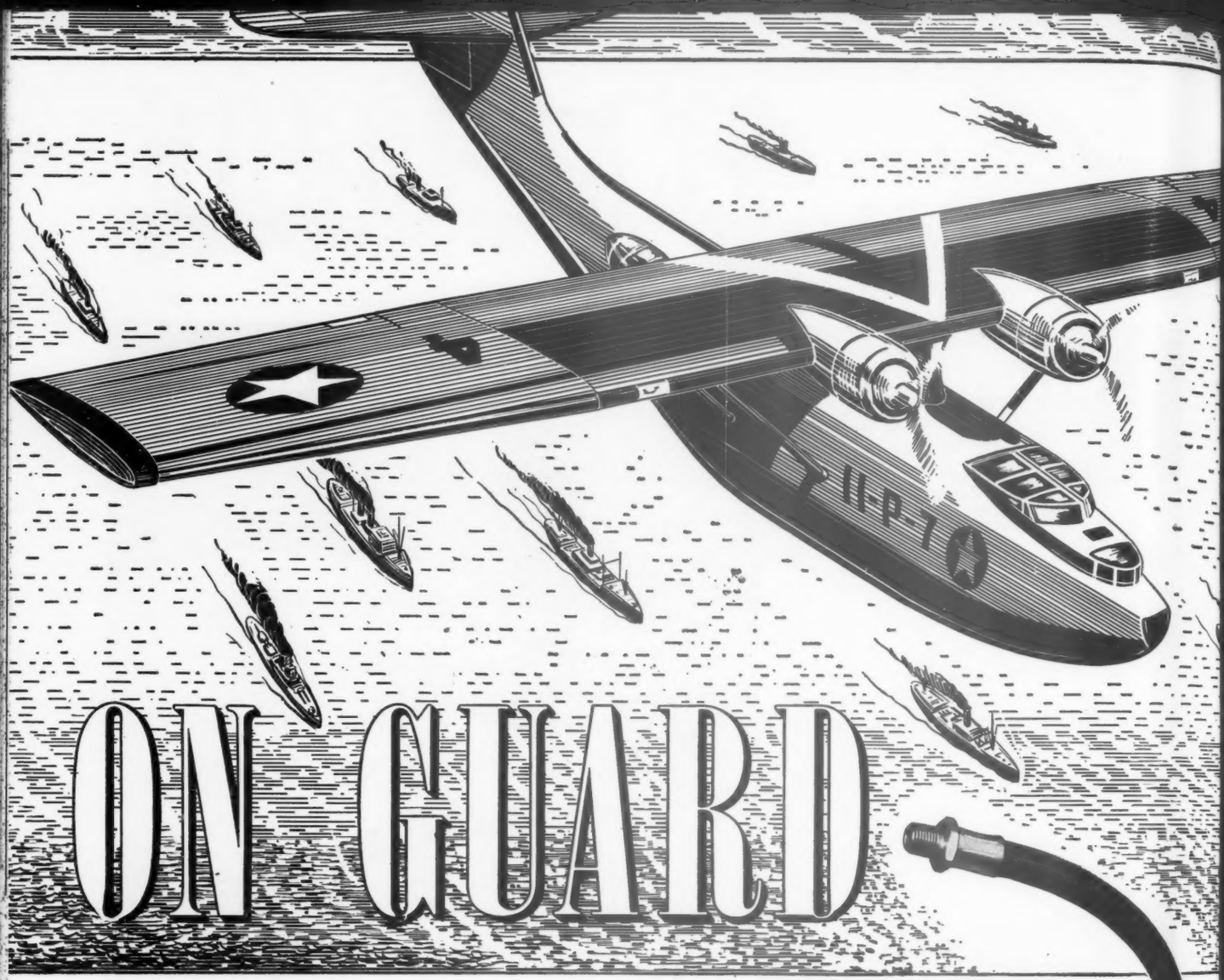
Write today, outlining your requirements, and complete information on this new PEC jig clamp will be rushed to you.

**SELF-ADJUSTING . . . QUICK-ACTING . . . INFINITE POSITIONS . . . DROP FORGED . . . POSITIVE LOCK**

PEC AIRCRAFT TOOLS

**Products Engineering Co.**

LOS ANGELES, CALIFORNIA




against Vibration, Varying Pressures and Extreme Temperature Changes

# WEATHERHEAD FLEXIBLE HOSE

BUILT to meet the toughest service demands, Weatherhead High, Medium, and Low Pressure Flexible Hydraulic Hose assemblies keep hydraulic forces flowing to vital mechanisms on every type of military and commercial plane.

Withstanding heat, cold, vibration, strain, and varying pulsations of pressure, Weatherhead assemblies are used for fuel lines, oil lines, instrument lines, and hydraulic applications of all kinds.

Prime contracts with the Army, Navy, Marines, and Coast Guard are evidence of the reliability of Weatherhead.

Other Weatherhead airplane accessories include Dural Tube and Pipe Fittings; Vacuum Selector and Check Valves; Hydraulic Check Valves; and Hydraulic Actuating Cylinders. All are manufactured to Air Corps, Navy, or "AN" specifications.

★ **THE WEATHERHEAD CO.**, *Main Office:* Cleveland, Ohio ★
**Branch Offices — Detroit, Los Angeles, New York, St. Louis**

WEATHERHEAD

equipped with a conveyor. It requires practically no attention except for loading and unloading the castings. As the furnace is but 20 ft. in length, the conveyor moves about 10 ft. an hour and it is a very simple matter to load and unload castings from and to the wheel rack on which they are delivered.

## World Cargo

(*Continued from page* 117)

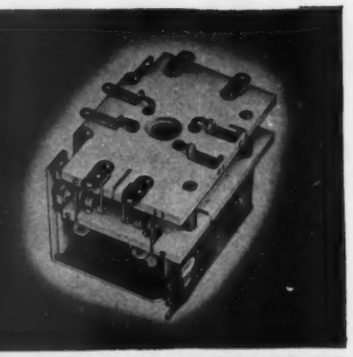
maintenance facilities. In setting up a worldwide airline system, the vast distances involved when operating over such deserts have required that the planes be ready to operate in and out of airports which were often little more than stretches of sand.

We soon found that perhaps the greatest single aid to maintaining those airplanes was to provide, as quickly as possible, surfaced runways for landing, taxiing, and takeoff. It is obvious that in the operation of combat airplanes there is very little leeway for choosing airports as a matter of convenience—note the case of fighting planes in the African desert, which must be expected to operate from the floor of the desert itself.

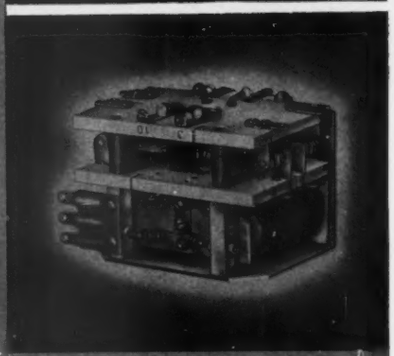
The first part of the plane to suffer was the engines. Sand raised from the suction of the propellers, or boiling up from the landing gear on takeoff or landing, is thrown almost directly into the carburetor air intake. Before the development of carburetor air intake filters, it was not uncommon for an engine to be completely "ground out" by sand in the barrels and accessories within 25 hours of operation. Filters of two main types have been developed with ramming and non-ramming intakes. It is obvious that power loss must be expected when using a non-ramming type, drawing the intake air in from behind the engine cowling instead of receiving the full pressure of the forward air blast. However, the increased serviceability of the filters themselves has been found to justify the present inclination toward the use of non-ramming intake. This is particularly true in view of the fact that the air filter is usually only necessary on takeoffs and landings, and the length of run available is usually not critical in the desert. The sand problem lessens with altitude, at which point the intake of air for the carburetor is switched over to the usual inlet taking rammed air off the leading edge of the cowl.

Protection of the airplane on the ground is also of extreme importance to achieve the maximum service life. We quickly found that it is not safe to leave an airplane standing for even an expected short length of time, on such desert fields, without thoroughly cov-


ALLIED CONTROL COMPANY, INC.



AK HIGH-SPEED KEYING BREAK-IN RELAY



Completely balanced... arms equipped with anti-bounce features

Magnetically held in both positions..does not rely on back spring pressure

Insulation plates of high pressure Steatite

Mounting features with elastic stop nuts

Keys at 20 cycles per second

All terminals easily accessible

Contact rating 1,000 volts at 30,000 feet..20 megacycles ..4 pole double throw

Wattage consumption 5.5 in first position .. 17.0 in second position

Withstands vibration to better than 20 G

Insulated to sustain 10,000 volts at sea level

Dimensions 2-7/16 x 3½ x 2¼

● AK a compact, high voltage, high speed, anti-vibration type keying relay for break-in operation in aircraft radio equipment. A push-pull magnetic arrangement which provides magnetic holding pressure on both transmit and receive contacts. One pole is equipped with two windings, one of which is a holding winding connected directly across the battery supply. The other winding is connected in series with the single winding on the other pole and polarized so that when the circuit is completed through the key, the flux is neutralized on the holding or receive position pole and the armature pulls up to the transmit position. Opening the key cuts off the bucking flux and the holding flux pulls armature back to receive position.

ALLIED CONTROL COMPANY, INC.

227 FULTON ST., NEW YORK

Factories

NEW YORK CITY • LONG ISLAND CITY

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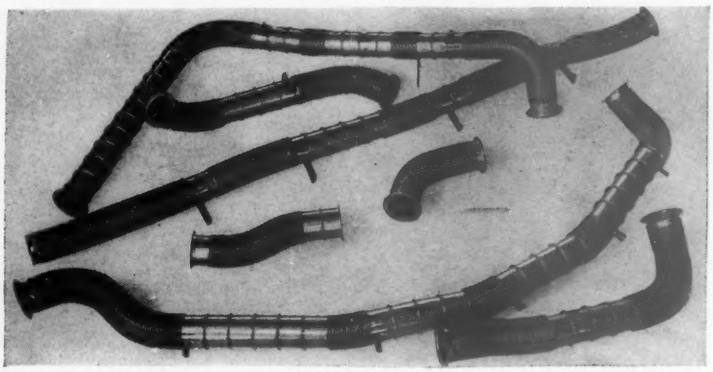
# REX-FLEX

## Stainless Steel Flexible Tubing

***SIMPLIFIES AIRCRAFT ASSEMBLY . . .***
***MAKES TOP PERFORMANCE DOUBLY SURE***



Units Shown are Typical Vari-formed Assemblies

Rex-Flex Stainless Steel Flexible Tubing combines the high fatigue value and the heat-and-corrosion-resistant qualities of stainless steel with extreme light weight and flexibility. Rex-Flex is bendable in multiple planes, available in long lengths, and can be "snaked" into place in cramped installations, eliminating joints. Simplifies and speeds up installation of air ducts, exhaust connections, blast tubes, heater ducts, power plant accessory parts.

Rex-Flex Stainless Steel Flexible Tubing is available in five wall-forms, all of which can be combined in a single one-piece length, with straight walls and corrugated sections at desired intervals. Sizes 5/16″ I.D. to 5″ I.D. inclusive. Made of 18-8 (Austenitic) Stainless Steel. Fittings are attached to tube ends by circular resistance seam welding. No flux, no flame, no quenching—producing absolutely tight, homogeneous assemblies.

**REX-FLEX is a production item originated to meet certain requirements of industry at peace. Fortunately REX-FLEX, as well as our older established Flexible Metal Hose products, have proved vitally important to our country at war. REX-FLEX is offered as a typical result of the engineering initiative and productive resource of this company. We welcome further tests of our ability to match our services to your needs.**

## CHICAGO METAL HOSE CORPORATION

**General Offices: MAYWOOD, ILLINOIS**
***Factories: Maywood and Elgin, Ill.***


ering openings which lead into the engines, as these wind storms are known to hit with only a few minutes notice. A crew may go in to lunch without pacing covers over the engines or over the carburetor air intakes, and return to find the sand blowing and inches of dust in the carburetors.

This also applies to engines having the new "short stack" exhaust outlets, where it is possible for sand to blow directly into the cylinder exhaust ports.

When there is the least likelihood that *sand* was on its way, Douglas found that the safest practice is to install engine covers (covering the propeller domes also and extending back over the exhaust outlets) and point the airplane into the wind.

Experience with a particular region of operation may also show that it is necessary to put on the canvas, cockpit and Plexiglas covers to avoid having the windshields thoroughly etched by the flying sand.

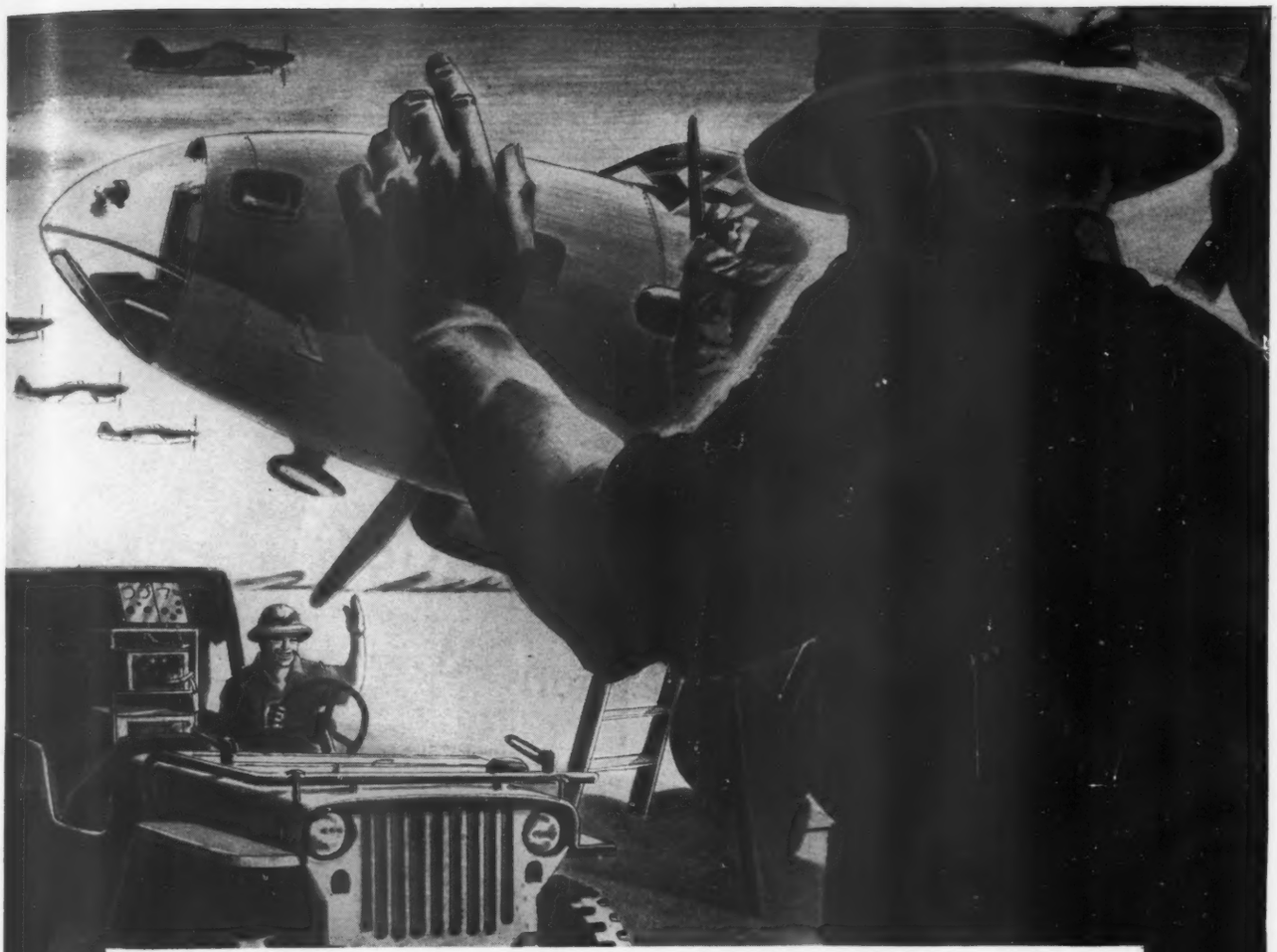
In spite of the protection applied, the maintenance crew can expect that after each "blow" it will be necessary to go back into the ship for a thorough cleaning. It can best be said that those desert sand storms *penetrate*.

As a result of the past experience, special provisions are now being incorporated to more fully protect hydraulic units from the intrusion of foreign matter.

Very soon, maintenance men can expect to see a round rubber or canvas "accordion" boot installed over the exposed surfaces of hydraulic shock-absorbing struts and actuating cylinder pistons. These serve the dual purpose of excluding dust from the interior of the hydraulic cylinder, contaminating the oil, and of preventing the abrasion and deterioration of the pistons and the packing themselves. It is well worth while for service personnel, under especially muddy or sandy operating conditions, to check these dust excluders and to patch up any holes that may result from flying rocks or rough handling.

On the C-54 transports, Douglas is now using an engine with the twin magnetos mounted on the nose section of the engine. From the service standpoint this represents a distinct improvement in accessibility, but it has also been necessary for the manufacturer to give particular thought to weatherproofing the magnetos. The increase of flying into driving tropical rains has necessitated particular care in sealing these units against moisture. Development of an "open-wire" electrical system for the aircraft itself is now being carried on. Elimination of the conduits now used to shield the fuselage and wing wiring will make this

(*Turn to page* 335)



# RADIO SERVICE MAN OUT OF *Cairo*

**Somewhere in Africa . . . or Iran, India, China . . . an American bomber returns to its base. Tomorrow, it will fly again . . . provided essential repairs are made tonight.**

**For this and numerous other such situations, BENDIX-RADIO Service Men are ever alert. Stationed at such centers as Cairo, Karachi and Kunming, within reach of advance bases of United Nations forces, these trained engineers are available at all times to render expert service.**

**Here on the home front, too, men and women of BENDIX-RADIO are doing their bit towards victory.**

Products of BENDIX-RADIO are important members of "The Invisible Crew"... the precision instruments and equipment which 25 Bendix plants from Coast to Coast are speeding to our fighting crews on World Battle Fronts.

THE INVISIBLE CREW
Precision Equipment by Bendix
AVIATION CORPORATION

BENDIX RADIO — BENDIX RADIO DIVISION

THESE insidious nonentities raise hob with pilots' nerves, chattering singsong misdirections, playing tag among the instruments, and generally making vicious nuisances of their mysterious selves.

One place they haven't been so successful with their mischief, however, is in the radio instruments, mainly because of Flexible Low-Tension Shielded Conduit that won't permit their sly whisperings and those distracting and interfering static-induced noises to get to the pilot's ears.

With the foolproof protection of Flexible Low-Tension Shielded Conduit, United Nations' flyers hear their radio signals and directions clearly, unfailingly.

American Metal Hose makes a complete line of fittings and accessories for American Flexible Low-Tension Shielded Conduit. Both fittings and conduit conform to A-N, A-C and NAF specifications. 42178

ANACONDA

American Metal Hose

AMERICAN METAL HOSE BRANCH OF THE AMERICAN BRASS COMPANY • General Offices: Waterbury, Conn.
*Subsidiary of Anaconda Copper Mining Company* • *In Canada:* ANACONDA AMERICAN BRASS LTD., *New Toronto, Ontario*

wiring much more accessible for the maintenance crews. However, some of the problems in connection with this open system change are not quite completed.

As we mentioned above, extremes of temperature are hard on rubber, and the heat and humidity of tropical operations definitely shorten the service life of rubber bungees. As a matter of fact, we found that the shipment, by boat, of spare bungees to distant tropical points where the boat ride might be a month or two, would deliver most of the bungees with half of their service life exhausted. We found that air shipment of such parts was justified to insure a reasonable life after installation on the planes awaiting them.

The comments made above regarding thermal expansion will also apply to units in tropical operation. It is to be expected that hydraulic fluid, locked in various parts of the system, will expand during the temperature change from the cool of the morning to the heat of the afternoon. It is necessary for maintenance men to check this occasionally, and if necessary relieve the pressure to avoid undue strain on dural lines or hydraulic hoses.

The effect of heat on Plexiglas surfaces is already quite well known from experience in southwestern United States desert bases. Under temperatures running to 170 deg., the expansion of Plexiglas in the larger panels causes it to bulge and take a permanent set. On some of the biggest panels, the Plexiglas may even sag inward again under its own weight, if not properly reinforced.

This condition can best be alleviated during maintenance by leaving enclosures open for ventilation within the airplane, so that the fuselage will not act as an oven with the hottest air along the top near the Plexiglas. In addition, it should be remembered that any dark cover, such as canvas, placed directly on the Plexiglas will greatly increase the heat absorption making the adjoining Plexiglas even hotter. Fortunately, the outdoor temperatures usually drop somewhat during a sandstorm.

Considering the sun temperatures which we have mentioned as common during the summer months, it is not difficult to visualize the physical problems which confront crews maintaining all-metal airplanes in tropic and subtropic zones. Imagine leaving a wrench out in the sun on the hottest summer day you can remember. Pick it up and burn your fingers, and you will understand what the skin of an airplane feels like anytime after eleven o'clock in the morning under those conditions.

At the present date, the scope of op-

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Increase efficiency of employees.
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Eliminate wracking of equipment.
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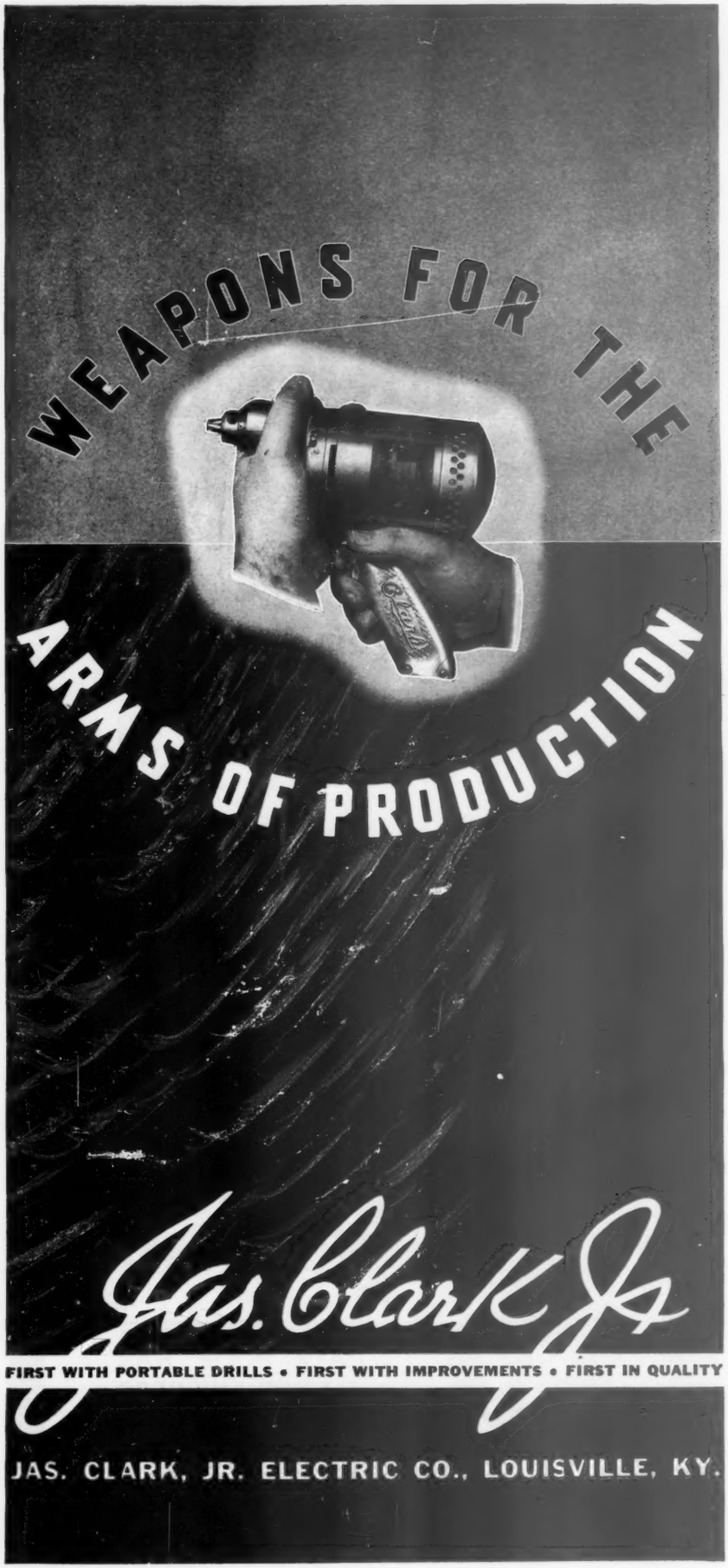
WEAPONS FOR THE
ARMS OF PRODUCTION
Jas. Clark Jr
FIRST WITH PORTABLE DRILLS • FIRST WITH IMPROVEMENTS • FIRST IN QUALITY
JAS. CLARK, JR. ELECTRIC CO., LOUISVILLE, KY.

erations has also brought a maintenance problem in connection with airplanes which are likely to travel from one temperature extreme to the other within a few hours, or even minutes. Due to the flexibility of operating schedules between many outlying stations, an airplane normally operating in the heat of the North African desert may suddenly be sent or transferred to the snowclad Elburz mountains or Eritrean highlands. The maintenance crew will have to remember to provide against the effects of temperature changes already noted, checking such items as oleo and tire inflation and proper lubricants.

Another new problem to American maintenance crews has been caused by the increasing use of aromatic fuels. Many of the gasolines produced by foreign fields, particularly those of the Middle East and East Indies, contain aromatics to the extent of 10 to 40 percent. These aromatic hydrocarbons, necessary to bring up the octane rating of those fuels, tend to accelerate the deterioration of rubber and synthetic rubber parts of the fuel systems. Fortunately, almost all Douglas airplanes are now equipped with recently developed aromatic-resistant synthetic rubbers on parts likely to be affected by aromatics. At the present moment, it is still our practice, when using aromatic fuels, to check the condition of carburetor diaphragms at least every 60 days. In regions with hot climates, particular attention should be paid to the manufacturer's recommendation that "stale" gasoline not be allowed to stand in the carburetors for any length of time. High ambient temperatures will apparently tend to "distill" the fuel remaining in the metering chambers, and service life of neoprene diaphragms will be increased by occasional flushing of the fuel in those chambers, if the airplane and carburetor are to remain idle more than a day or so. In this connection, the carburetor manufacturers are developing, and will soon have out, new diaphragms of a synthetic which is satisfactorily aromatic resistant.

For the best economy of fuel consumption, horsepower output and engine rpm. are considerably lower on present long flights than has been the practice in normal domestic United States flight operation. We have found that vibration in our transport airplane is considerably increased when the engines are operated at around 1,400 rpm. or around 1,900 rpm. The difference in operating procedures between several of our customers has been found to have a definite effect on the service life of certain units subject to vibration. Naturally, this subject ties in directly with the loads, both cargo and

(*Turn to page* 339)

# Use LORD MOUNTINGS

BONDED RUBBER

## FOR CONTROLLING VIBRATION IN AIRCRAFT

### PLATE FORM MOUNTINGS
For

- CABIN INTERCOOLERS
- CABIN SUPERCHARGERS
- AUTOMATIC PILOTS
- PROPELLER SPINNERS
- INSTRUMENT PANELS
- CARTRIDGE STARTERS
- BOMB SIGHTS
- COMPASSES
- MICROPHONES
- CARBURETORS
- RADIOS
- CAMERAS
- ANTENNAS
- RADIATORS
- OIL TANKS
- BATTERY BOXES
- AUTOSYN DEVICES
- AUXILIARY POWER EQUIPMENT
- FLIGHT ANALYZERS
- EXHAUST GAS ANALYZERS
- VOLTAGE CONTROL BOXES

### TUBE FORM MOUNTINGS
For

- SEATS
- COWLS
- RADIO TABLES
- RADIAL ENGINES
- IN-LINE ENGINES
- NAVIGATOR'S TABLES
- CONTROL ROD JOINTS
- TAIL WHEEL ASSEMBLIES
- LANDING WHEEL ASSEMBLIES
- OIL TANKS
- RADIATORS
- ELEVATOR CONTROL RODS
- MOTOR BRUSH MOUNTINGS

## LORD DYNAFOCAL SUSPENSION for RADIAL ENGINES

Lord Dynafocal Engine Mountings for radial engines provide a unique type of center of gravity suspension which isolates all forms of vibration caused by engines and propellers, yet retaining all of the stability characteristics of conventional overhung suspensions. These mountings, in various styles, are available for engines of 450 HP and up.

Primarily, the Type RS-40 Dynafocal Suspension was developed for use with the Wright 18 Cylinder Cyclone Engine. It was designed with the thought of including the more desirable features of the earlier link type and flexible pedestal type suspension; and in addition, provide effective snubbing and damping means through the use of three ball joints and a rubber snubbing ring. Write for data.

Lord's exclusive method of producing a strong and uniform bond between rubber and metal makes possible the manufacture of compact, light weight mountings, particularly adaptable to aircraft.

When load is applied to the mounting in the direction of its main axis, the mounting operates in free shear, providing a soft suspension with high vibration isolation efficiency, yet ample stability in other directions, for the complete mounted system.

The dependability and efficiency of Lord Mountings in protecting equipment listed above from vibration and landing shock, is attested to by the fact that they are used on practically every military and commercial plane in this country. The services of Lord Engineers, who have had a wide experience in aircraft vibration control, are available without obligation.

BONDED RUBBER SHEAR TYPE MOUNTINGS
For Engines, Cowls, Instrument Panels, Radios, etc. . . . Dynafocal Suspension For Radial Engines

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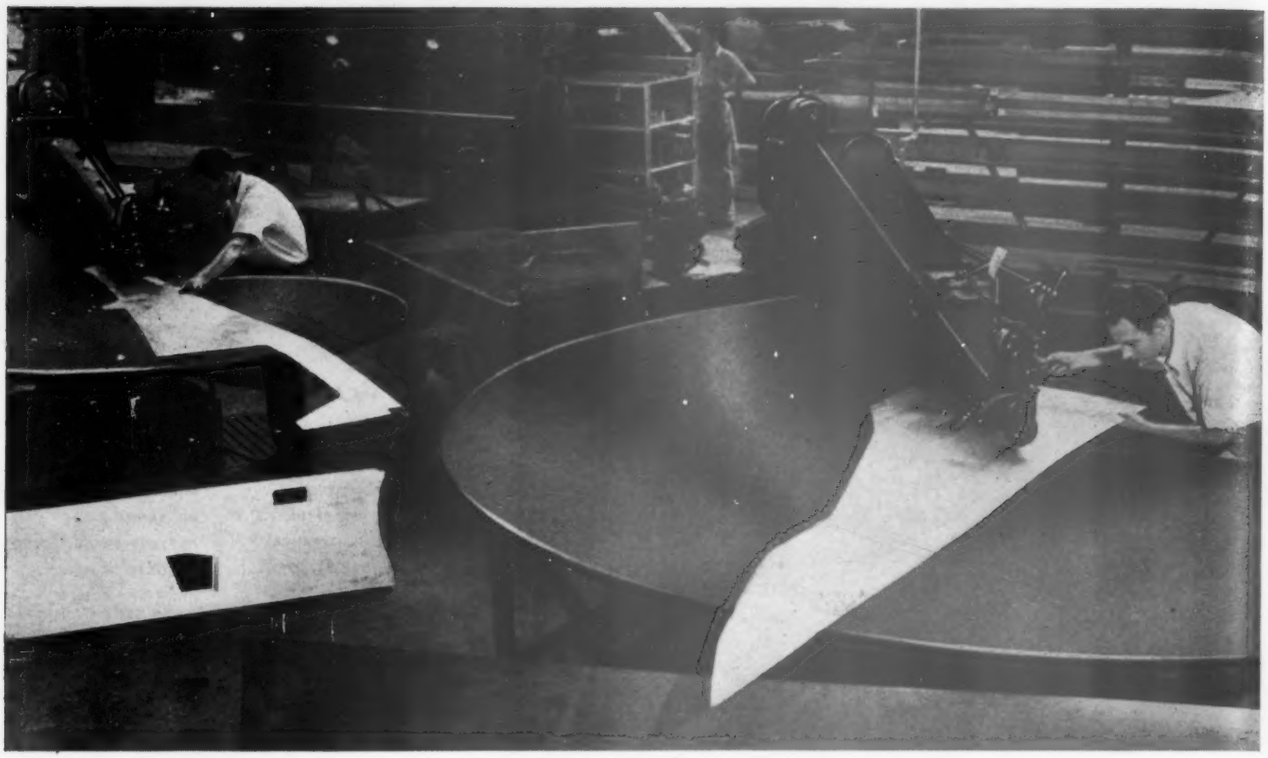
IT TAKES RUBBER IN SHEAR TO ABSORB VIBRATION



# HOW TO CUT OUT AN AIRPLANE WING

*Above: Cutting out wing section in an aircraft plant with the Quickwork. Below: Trimming airplane stampings is fast, accurate with Quickwork No. 8 Rotary Shear.*

# OR TRIM A STAMPING

For accurate shearing of stainless or dural plate . . . for speeds up to 40 ft. or more per minute—use Quickwork-Whiting Rotary Shears. This versatile machine actually does the work of seven machines—saving space, time, labor. Operations include: cutting straight lines, narrow strips, circles, irregular shapes, flanging, and joggling. Available in 12 standard models . . . capacities up to 1″ mild steel.

The Quickwork is widely used in the making of parts for airplanes. For information, write

"QUICKWORK"

**WHITING**

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The Aviation Industry Is Served by Whiting Corporation with Cranes • Tools • and Matched Maintenance and Handling Equipment

aerodynamic, to which the airplanes are subjected. As a generalization, however, we have noticed that closer maintenance inspection is required, for instance, on the tail surface attaching fittings, if that particular airplane is operated at those low rpm. giving increased vibration. This item also has a considerable effect on units in the powerplant section, where failures of attaching brackets and fittings have been known to occur much earlier than should be expected, traceable to increased vibration by the use of unfavorable power and rpm. combinations. It is, therefore, questionable at times whether power output should be chosen to obtain the most economical fuel consumption, or should be increased somewhat to avoid undue maintenance costs, because of increased vibration.

We are sorry to say that we have noticed that one of the most neglected items, affecting the service life of transport airplanes being operated abroad, is proper attention to the cargo. Loading charts, as published in the past, have been more complicated than is desirable for easy use, and considerable effort has been put into providing this loading data in a simpler form. However, it is imperative that ground crews understand the basic limitations controlling cargo loading for the airplanes they are handling.

When limits for the fore and aft balance of an airplane expressed in percentages of the mean aerodynamic chord have been established, you have undoubtedly learned by experience that these limits can be exceeded to a certain degree without apparent danger. This has led to a bad practice of loading cargo in an airplane by sight. Assuming that the cargo "looks good," it is okay. Because of this, quite a few airplanes have gone through the fence instead of leaving the airport. Since the ground crew doesn't want to see their airplane left hanging on the fence at the end of the field, it is extremely important that they give careful consideration to how much of a load they are putting in an airplane, and to insure that the load is placed within the specified limits of CG location.

Maintenance men have found for instance that if an airplane is constantly loaded with the CG "just a little" aft of specification they are going to have a lot more trouble with stabilizer attaching fittings. The pilot can trim out the unbalance with 4 or 5 deg. of elevator tab, but that only means that the tail group is subjected to a preloading, shortening its service life, because the ground crew did not properly balance the cargo.

Long-range flights have also brought


A LIFESAVER for the aircraft mechanic

Note the switching device which automatically grounds the magneto when fittings are disconnected.

This dual magneto grounding plug guards the lives of the ground crew mechanics as they swarm over a plane during service and repair operations. Without such a safety device, any movement of the propeller might accidentally start the engine with tragic results.

With this Cannon Plug it is not necessary for anyone to remember to ground the magneto after the engine circuits have been disconnected for servicing. This is a typical example of how Cannon Plugs are used for a wide variety of applications in aircraft and other fields.

CANNON SERVES MANY INDUSTRIES

Cannon precision-type multi-contact connectors are made in countless shapes, sizes and styles, and are backed by twenty-seven years of electrical specialty manufacturing experience. They have become standard equipment in radio, television, aircraft, motion pictures and countless other fields.

CANNON ELECTRIC

Cannon Electric Development Company, Los Angeles, Calif.

Canadian Factory and Engineering Office: Cannon Electric Company, Limited, Toronto, Canada

# 4 TIME AND MONEY SAVERS for PLANE BUILDERS

**1. TO ELIMINATE GRINDING OFF WELD SPATTER . . .** *Acme Quality Industrial Finish Flash-Off No. 99.* Mechanic simply sprays, brushes, or wipes FLASH-OFF along edges of metal to be joined by weld. FLASH-OFF makes metal chips bounce off instead of adhering to areas adjacent to weld. FLASH-OFF also helps improve quality of weld. Being an excellent conductor, it helps prevent the weld arc from breaking, thereby producing stronger weld. It also prevents pitting of galvanized, ungalvanized, or "stainless" steel surfaces. Paint can be applied immediately after removing FLASH-OFF with damp rag. Low in cost. Comes in 55-gal. drums—and 5-gal. cans.

**2. TO SIMPLIFY SCRIBING INSTRUCTIONS ON SHEET METAL . . .** *Acme Quality Lay-Out Dye.* Semitransparent, extremely fast drying (about 1 minute), purple in color. Can be brushed, wiped, or sprayed on sheet metal. Work instructions scribed with sharp stylus or other sharp-pointed tool stand out bright and clear. When work has been completed, remaining LAY-OUT DYE can be washed off with denatured alcohol. Film is so thin that removal is unnecessary in many cases. Comes in quarts and gallons. Now widely used in many large plants.

**3. FOR CLEANER THREADS AND SMOOTHER FORMING . . .** *Acme Quality Tapping and Drawing Compound.* Better than lead and oil because TAPPING AND DRAWING COMPOUND *does not harden* on work, whereas lead and oil must be cleaned off immediately. It comes in paste form and is reduced to milky consistency with paraffine or other cutting oil for use in machines with circulating pumps. For sheet metal stamping, it is reduced to consistency of thin paint with any thin oil. Can be splashed, brushed, or sprayed on. Very economical—prevents accelerated wear on expensive broaches, and other cutting tools and dies.

**4. FOR FULL-SIZED LAY-OUT WORK ON METAL SHEETS . . .** *Acme Quality Velunite Draft Board White.* Widely used by airplanes, engines, parts, auto body and truck builders. Draft Board White is designed for 25% reduction with Acme Quality F-40 reducer. You spray on a "mist" coat of least possible film thickness. When dry, spray on full, double crossed coat. Allow to dry overnight. Does not become brittle with age nor chip under compass point.

ALL FOUR OF THESE MONEY SAVERS AVAILABLE THROUGH ACME BRANCHES LOCATED IN PRINCIPAL CITIES

*Full details upon request. Address inquiries to*

**ACME WHITE LEAD & COLOR WORKS**

*Dept. F; Detroit, Michigan*


increased attention to the navigator, consequently it has become necessary to insure that the navigator's turret is in the most accessible location and may be readily cleaned in flight. The navigator's turret has also provided a possibility for affording easy access to the top of large airplanes for the ground crew.

Also, in connection with present-day flights of greater length, it has become necessary for manufacturers and maintenance men to do their utmost to relieve crew fatigue. This includes attention to heating systems, seats, footrests, crew bunks, visibility and clean windshields, even ash trays. The neglect of any of these items will certainly contribute to reduction of the efficiency of the flight crew.

We should like to mention that too great an emphasis cannot be placed on the importance of the *condition* of the airports from which transport planes are to be operated. Although present planes have already shown themselves capable of operating in and out of the poorest fields, it is only natural that those planes will require far less maintenance if reasonable attention is first given to the airport. Combat airplanes obviously must be expected to operate under the most adverse conditions, with no recourse. Transport air bases, however, can enjoy the advantages of greater permanence and efficiency.

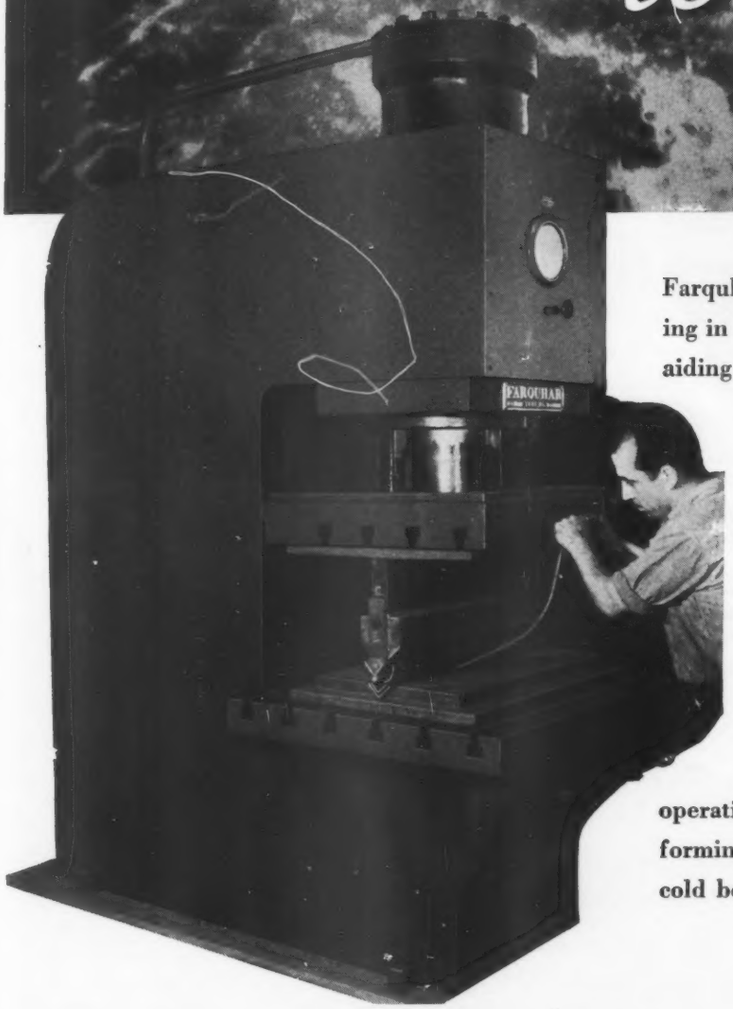
It's always well to remember that the maintenance of any airplane starts from the ground up, and the investment of time and effort in providing smooth runways, taxi strips, and engine run areas, will be amply repaid in reduction of the maintenance difficulties resulting.

Under present conditions, enough troubles are already encountered *training* maintenance personnel for air base work within the United States. When we realize that ground crews at foreign bases are absolutely on their own, it is plain that great care must be taken in choosing and training those crews if the airplanes are to receive proper attention under the adverse conditions to be expected. It is extremely necessary that men at these foreign stations be possessed of any unusually high degree of initiative. Tools and equipment at those bases are not yet as complete as we are accustomed to here, and it is imperative that field crews, headed for foreign service, plan to take with them all of the equipment that they can expect to need. In spite of the best planning allowable under the "forced draft" of today's pace, it is probable that some items will be overlooked.

However, it has now been our

(*Turn to page* 343)

# To get more ships "Down to the Sea"



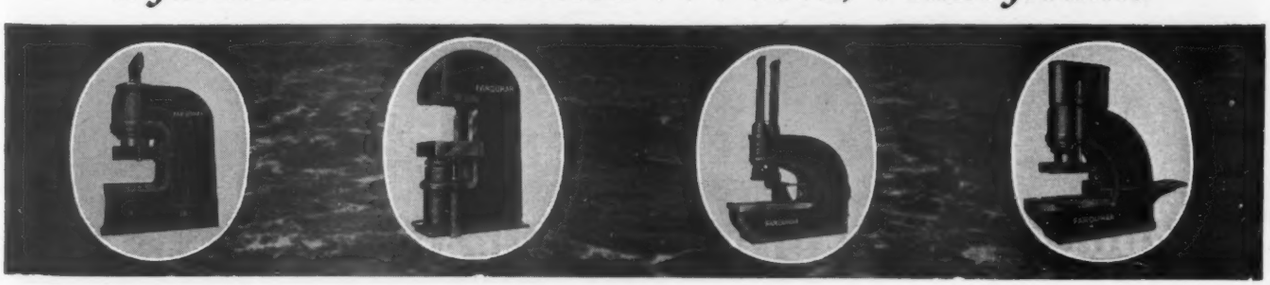

Farquhar Self-Contained Hydraulic Presses are serving in Navy and private shipyards all over America—aiding in the production battle to get more ships "Down to the Sea."

Powerful hydraulic presses will continue to aid the "Ships for Victory" drive, by supplying quick means of shaping metal for aircraft, ships and tanks. Farquhar presses are built for all shipbuilding purposes from three to 7,200 ton capacities.

The hydraulic press shown is working continuously at the plant of the Electric Boat Company on bending and straightening operations. This press does a large variety of metal forming jobs ranging up to ½ inch thick steel for cold bends and up to 1¼ inch for heated jobs.

## A. B. FARQUHAR CO., Limited

*Hydraulic Press Division . . . York, Pennsylvania*



# READY FOR DUTY

## IN ARCTIC COLD—
## IN TROPIC HEAT!

Today—flying in all the world's climates—the Army Air Corps demands Radio Phones that will function perfectly everywhere . . . in the frigid air of the stratosphere—in the blazing heat of the desert. It's no easy task to build sensitive instruments for such a temperature range!

*Murdock Precision-Built* Radio Phones meet Army specifications. They are standard equipment with the Air Corps wherever it fights.

Serving the Cause of Victory

**Murdock**
**RADIO PHONES**

**MURDOCK MANUFACTURING COMPANY—Chelsea, Mass.**

pleasure to see how quickly American mechanics and field personnel have shown themselves capable of reverting to Yankee ingenuity in solving problems formerly nonexistant under the facilities available back in the United States.

The subject of spare parts for maintenance of airplanes abroad would certainly deserve a separate book in itself. We should like to mention here, however, that if we expect to "Keep 'Em Flying"—*Get the spares out to the crews who need them!* The comparatively wide variety of the models now being produced by this country has been the subject of considerable discussion. However, that variety requires that information on interchangeability of parts must be supplied to crews and stockrooms in the field. An air base handling several models of airplanes may not have available a needed replacement part of the particular part number for that airplane. An identical part, or one which may be used in its place, may exist under a different part number for this airplane. If these stockrooms are not informed regarding the allowable interchangeability of such parts carrying different numbers, it can be expected that replacements will be ordered from the main base or from the factory, when a part is already available which could have been used. On the other hand, without such information on interchangeability it is possible for field crews to substitute a part which "looks just like" the one desired but which should not be used, perhaps because its strength is less than that of the correct part, or perhaps because of some functional difference not easily seen.

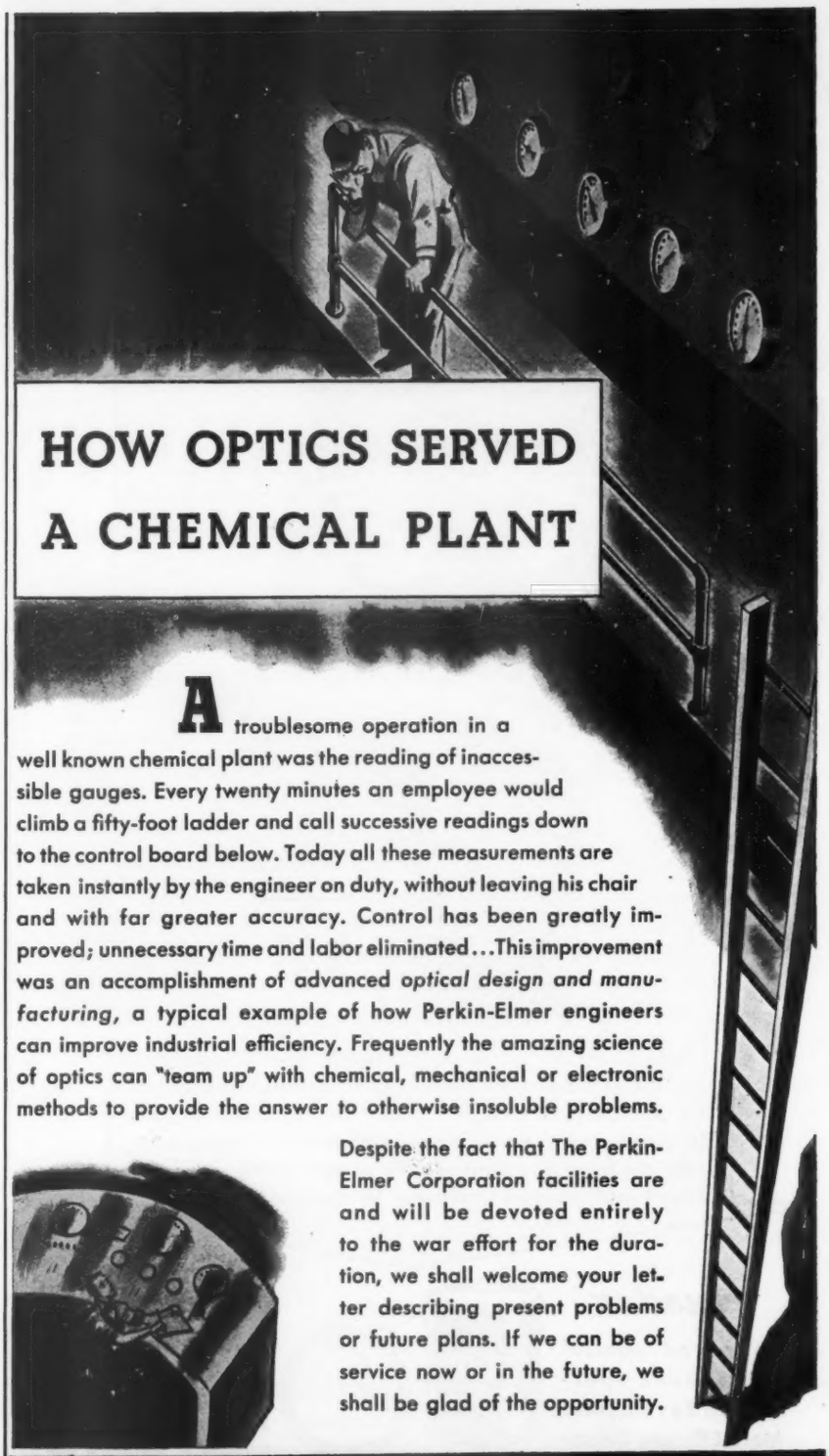
Maintenance men will be glad to hear that Douglas and other manufacturers are placing increasing emphasis on the consideration that accessibility means serviceability. We certainly hope that improved installations of access openings are contributing to the easier and faster maintenance of our many airplanes.

The next few years will certainly see much more written into the record of "round the world" air transport. Today we are off to a flying start and the mutual efforts of maintenance men, pilots, and manufacturers, should do much to contribute to the final effectiveness of these United States' contribution to the far-flung United Nations Supply Line.

## Womanpower

(*Continued from page* 127)

Mrs. Salley Delong, is doing drafting. All three are doing work, or preparing for it, that is almost identical with that done by their husbands. In our brief

HOW OPTICS SERVED A CHEMICAL PLANT

A troublesome operation in a well known chemical plant was the reading of inaccessible gauges. Every twenty minutes an employee would climb a fifty-foot ladder and call successive readings down to the control board below. Today all these measurements are taken instantly by the engineer on duty, without leaving his chair and with far greater accuracy. Control has been greatly improved; unnecessary time and labor eliminated...This improvement was an accomplishment of advanced *optical design and manufacturing*, a typical example of how Perkin-Elmer engineers can improve industrial efficiency. Frequently the amazing science of optics can "team up" with chemical, mechanical or electronic methods to provide the answer to otherwise insoluble problems.



Despite the fact that The Perkin-Elmer Corporation facilities are and will be devoted entirely to the war effort for the duration, we shall welcome your letter describing present problems or future plans. If we can be of service now or in the future, we shall be glad of the opportunity.

THE PERKIN-ELMER CORPORATION

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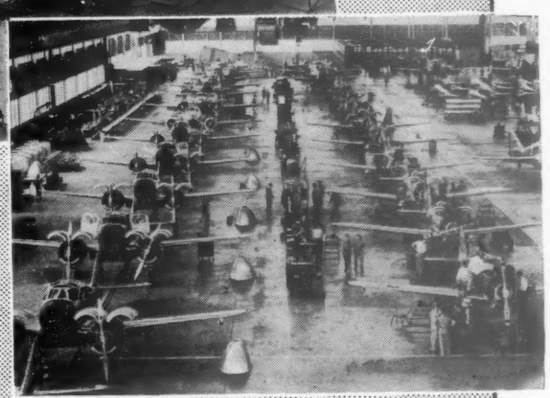
OPTICAL DESIGN AND CONSULTATION

# SEE HOW THESE APPROVED CHEMICALS & COMPOUNDS PERFECTED FOR AVIATION IMPROVE YOUR PRODUCTS



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experience with women we have discovered that most women prefer to do work similar to that done by their husbands, brothers or fathers.

Included in our current mechanics classes, of course, are many men, some of them recruited from the ranks of former garage mechanics, some older men, and many from other businesses but who have shown mechanical ability. In addition to actual shop work, they too attend classes where crew chiefs explain equipment, accessories, tools, techniques, and all other phases of the work they will do.

When the full story of this period can be told, it will not be merely one of unbelievable expansion of hours flown, tons hauled, or routes pioneered, but will also include a chapter on maintenance that will cover some of the toughest problems the airlines have had to solve. And not the least of these will be the replacement of manpower with womanpower in the shops.

## Aircraft Maintenance War

(*Continued from page* 119)

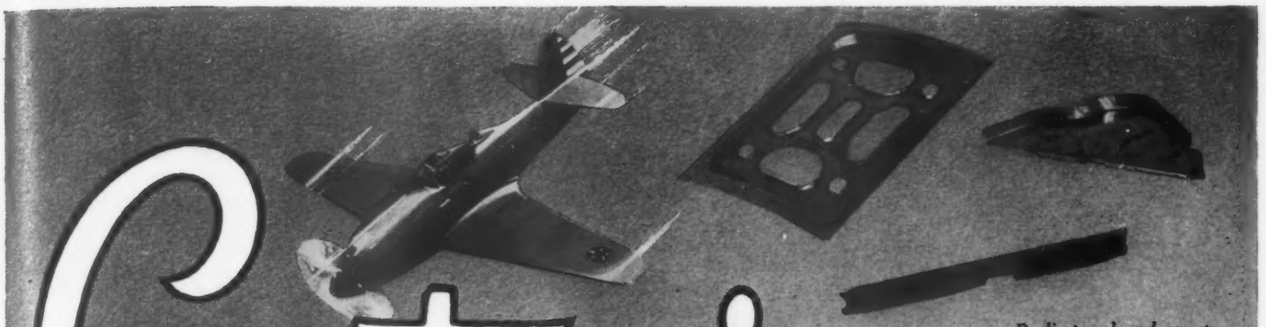
a completely equipped repair and overhaul shop for the handling of 33 types of aircraft, plus accessories, engines, and propellers.

In three months time all equipment, materials, plus a personnel of several thousands, had been accumulated and shipped to the site of operations, and in another month preliminary operation had begun. The base is now handling production quantities of aircraft, engines, propellers, and all the varied accessories required to keep our aircraft flying. This miracle of organization and construction speed has been repeated around the world in the past year.

Maintenance bases generally fall into two classes: (1) Depot groups providing the smaller mobile type of overhaul, and (2) the large permanent supply depots. Because the developments of war are hardly predictable the depot groups must be completely flexible, ready for movement at any time. Since our armies now depend on our AAF for all major operations, and since the AAF must necessarily depend upon precise and reliable maintenance, the movement of maintenance equipment and parts is of the same key importance as any other line of supply serving our fighting operations.

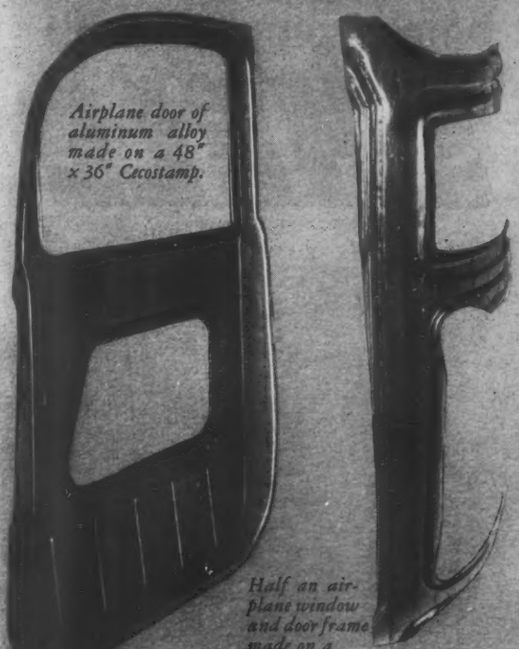
Controlling the maintenance of our Army aircraft is the vast Air Service Command, which in 1941 was called the Maintenance Command. Now under the direction of Maj-Gen. W. H. Frank, the Air Service Command unquestionably has been assigned one of the most

(*Turn to page* 347)



# Cecostampings

*Radio panel and gussets made of aluminum alloy.*



*Airplane door of aluminum alloy made on a 48" x 36" Cecostamp.*

*Half an airplane window and door frame made on a 66" x 36" Cecostamp.*

Unlike most other machinery being used in the war effort, the Cecostamp is something new in production machinery. An original design by Chambersburg Engineering Company, the Cecostamp is a high production impact type stamping machine for forming high strength sheet metal parts such as stainless steel and many aluminum alloys. By using a Cecostamp, it is possible to form difficult metals with greater true-to-die accuracy and fewer operations. The operator has control at all times of the metal flow of the stamping and is able, therefore, to produce desired shapes without drawing or a reduction in sectional areas. Controlled stamping overcomes the resiliency of hard-to-form metals while giving them a permanent set at a greater rate of production. A few examples of Cecostampings are shown.

For complete details of Cecostamping and more examples write for a copy of "Cecostampings."

**CHAMBERSBURG ENGINEERING CO.**
**CHAMBERSBURG PENNA.**

*Cover*

**CECOSTAMP**

*The modern drop stamp for difficult forming of high strength steel and aluminum alloy sheet metal parts.*

*Airplane nose or spinner of stainless steel made on a 66" x 48" Cecostamp.*

**CHAMBERSBURG**

# CECOSTAMP

**HAMMERS PRESSES**

# A B-24 LIBERATOR BLASTS ITS TARGET TO BITS

The big B-24 comes roaring in over the target, the "ack-ack" rocking it with near-hits. But straight and true it flies . . . drops its "eggs" and heads for home.

There must be no gamble when these Liberators take the air. As they roll off the production lines, Consolidated* fuels and lubricates B-24's (Liberators), PBY's (Catalinas) and its famous PB2Y's (Coronados) with Shell Products. Preference for Shell Aviation Fuels and AeroShell Oils carries from coast to coast among many plane and engine manufacturers, aviation training schools, transport lines and airports.

*That's the reason airport operators the country over have found Shell's fast-growing line of products profitable to handle.*

**Consolidated fuels and lubricates its powerful bomber engines with**

# SHELL

Model of Liberator B-24 shown courtesy Consolidated Aircraft Corp. *Originator of the Liberator . . . Catalina . . . Coronado.

(*Continued from page 344*)

stupendous tasks of the entire war, not alone in maintenance but in supply of the necessary parts, materials, and machinery to those most remote corners of the earth where these aircraft are required to fight.

The Air Service Command headquarters is housed in a huge new building at Patterson Field. There, groups work to eliminate the troubles that occur to our aircraft, other groups are engaged in developing the most efficient types of tools for maintenance, still others attend to the big job of procurement and distribution of the great quantity of parts which must be delivered to each fighting base.

In addition, there are the depot groups controlling the operation of the great domestic supply and overhaul depots, also the United Nations group concerned with the supply of materials to all of the anti-Axis Allies.

A seemingly insurmountable task is being accomplished by this organization. Indeed, as the job becomes increasingly difficult because of more widespread operations and greater numbers of aircraft, the men responsible seem to analyze their problems even more calmly and more directly than before.

One of the tremendous problems is the acquisition of parts for all of the various engines, propellers, instruments, and thousands of other pieces of equipment which must be overhauled and maintained. The modern military airplane is a complex machine, to say the least. By no stretch of the imagination can it be expected to function indefinitely without replacement of worn parts, parts damaged by gun fire, or parts impaired in operation activity. This supply is as vital as any Air Service Command job, since the lack of almost any one of the small parts may ground a plane or cause its subsequent loss in combat. Responsibility of the men who must supply the parts to keep our aircraft in the air cannot be over emphasized.

Backbone of a military air service is comprised of the men who make up the squadrons. Similarly it may be said that the backbone of aircraft maintenance is gaged by the caliber of personnel responsible for such maintenance. At the beginning of the war, there were probably not more than 15,000 trained aircraft-and-engine mechanics in the United States. Task of training the hundreds of thousands required to maintain our planes was given to the Army Air Forces Technical Training Command, under supervision of Maj.-Gen. Weaver.

Recognizing, on our entry into the war, that those knowing most about our aircraft were the airplane makers, Gen. Weaver immediately called upon the manufacturers to set up schools to train several hundred Air Force mechanics monthly. At the time this directive was issued, Lockheed was in the fortunate position of having operated such a school for several years, consequently was able to swing into immediate action. This school is now training mechanics in the maintenance of B-17's, P-38's, A-28's and 29's (*Hudsons*), and B-34's (*Venturas*).

*Experts conduct classes at plant, turn out tens of thousands of specialized mechanics for AAF. Here, instructor explains details of Fowler flap with graphic sketch.*

What are you doing about

PLASTICS ?

NOW is the time to learn about plastics—so you may take advantage of this industry's important new developments—so you can apply to your duties or products the *last word* in plastics. The Plastics Institute is already rendering a valuable service to far-sighted men—in the three activities listed below—send for full information on the phase that interests you most.

**SPARE TIME TRAINING**

For spare time education, the Basic Lesson Assignments bring you clear definitions of the different types of plastic materials. The machinery and methods of the plastics industry are clearly illustrated and described. Technical details are explained fully.

**STUDY-FORUMS**

The Plastics Institute conducts Study-Forums in many industrial centers for the convenience of men interested in more complete and practical training in plastics. Each Forum is conducted by a recognized authority. Write for address nearest Study-Forum.

**RESIDENT COURSE**

Designed for men who need a complete, comprehensive plastics education, including shop and laboratory training, the Plastics Institute offers a comprehensive Plastics Engineering Course. This one year course is available only at the Institute in Los Angeles—and classes are restricted.

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In addition to the factory schools, Lockheed has built Technical Training Command mobile training units consisting of completely equipped trailers carrying mockups of all operating systems of the aircraft and designed to circulate from squadron to squadron for ten-day stands. These units are supplied with Lockheed and AAF instructors, and thus a great number of the problems arising in the operating squadrons may be attacked on the spot by reference to the Technical Training Unit.

Other schools have sprung up throughout the country for training of various classifications of maintenance mechanics, and the men attending them have been found both eager to learn and of high caliber. The supply of trained personnel required for maintaining our aircraft *is* being procured!

Now to that perplexing problem of transportation of required parts and technical personnel to distant bases across the seas: Here was a task of huge proportions—but it is being met very adequately by the Air Transport Command. As the Transport Command's fleet of aircraft grows, the problems of far-away maintenance diminish, because through the operation of these fleets of aircraft we are able to deliver to our fighting squadrons the parts, information, and personnel they so sorely need. Fact is that the Air Transport Command operates the greatest airline on earth, and it grows daily in size.

This prodigious operation has tapped the vital and excellent fund of experience available from the nation's airlines. We are indeed fortunate that our great airline system had progressed to such an advanced point prior to Dec. 7. This immediate wealth of experience has enabled our Army transport system to expand by leaps and bounds where otherwise a lengthy and costly period of training would have been required.

All of the foregoing endeavors are being welded into an integrated whole to keep our aircraft flying. A vital aircraft part to Australia. . . a trained technician to Cairo . . . a million gallons of fuel to England . . . or a set of aircraft jacks to South America! These calls typify some of the problems which flood the Air Service Command daily. Each problem must be dealt with individually, analytically. Each requires close cooperation and correlation of efforts of our various Army Air Forces Commands.

The fundamental maintenance problems of war are probably no greater than those which would confront us in peacetime if we were operating in the deserts of Libya, the weather-bound Aleutians, or the jungles of New Guinea. It's just that these problems are magnified to the nth degree by the requirement that they must all be done at the same time and that their strict execution is demanded by the compelling double-headed urgency of rapidity and accuracy.

Lockheed's overseas bases, the first of which was established more than two years ago, are affording our engineers a source of vital information which will enable us to build more durable, easier-to-maintain aircraft. This vast fund of experience cannot fail to aid us in making our fighting aircraft more formidable and reliable as new designs come from the factory.

Lockheed has placed field service representatives in every one of the United Nations where Lockheed aircraft are flying. These technicians are trained at the factory to contribute technical ability and knowledge which will help keep our aircraft in the air. As a matter of fact, these men will pitch in and help on any aircraft, regardless of manufacture.

At their West Coast factories, Lockheed and Vega conduct an experimental

(*Turn to page* 351)

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● Designed for use with interchangeable mounting plates for radial engines, this stand has an entirely enclosed gear drive and adjustable arm brackets which make it easy to obtain the center of gravity on a wide range of engines. Speeds inspection, servicing and overhauling. Equipped with friction floor stop, removable oil pan, steel ball bearing casters. Write or wire for descriptive literature on our complete line of stands for aeroplane and tank engines.

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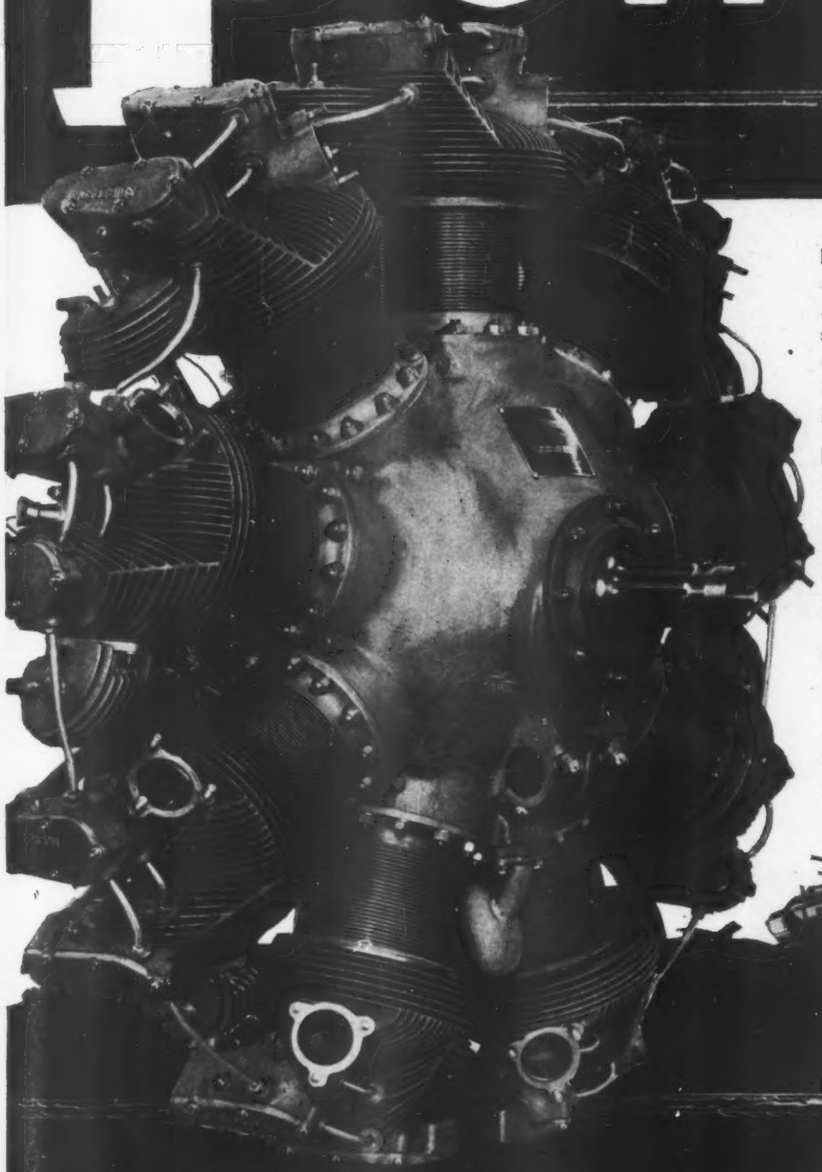

**POWER THAT HITS HARDER, FASTER, FARTHER**—that's Diesel Power! And that is the power that America needs and is getting from the Guiberson Radial Diesel Engine to help the democracies out-pound the Axis. Guiberson Diesels for tank and aircraft use weigh less than 2 pounds per Horsepower.

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*"-- it ain't the individual nor the army as a whole, but the everlastin' teamwork of every bloomin' soul"*
Rudyard Kipling

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maintenance laboratory in the form of a service shop where repair and overhaul methods are developed to speed operation in the field, where new types of tools and jigs are built, and where the various other equipment required to service aircraft is developed and proven. It was here that the mobile training units were manufactured. The trained men who accompany these units in the field were another important product.

There you have the picture of the myriad, complex endeavors, each of which contributes, in its own way, to the maintenance of our aircraft. All of the Commands of our Army Air Forces and all of the manufacturers of our aircraft, engines and parts, *ad infinitum,* are working together—a great team to help our combat flyers "carry the ball." Surely such a determined mass effort assures the attainment of our ultimate goal—*Victory!*

## Standards Committee Program

(*Continued from page* 165)

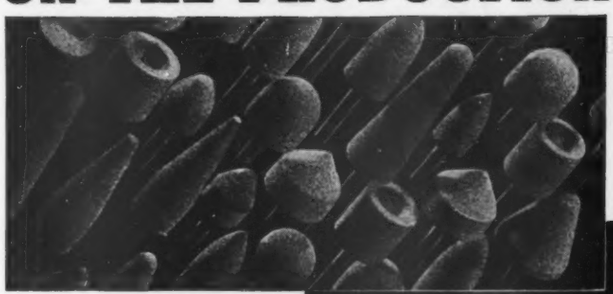
Standards Committees met in St. Louis and let down a lot of hair. There were many differences of opinion, for little or no reason, except perhaps that the several engineering organizations had never before tried to work together. There was a period of getting acquainted which illustrates very well the advantage of a permanent working group. Now that the representation is fairly fixed, with few personnel changes, the committee knows the intents and methods of the member companies, and the solutions are somewhat expedited. This advantage should be better understood.

The brief past of the committee is one of lifting by its own bootstraps. The industry is new, and the general concept of "standards" as something "frozen" in design has precluded much constructive standardization. Actually, a standard does not freeze or limit development of a design, but simply holds one part stable for a period while a new principle is developed in another. This is a major point for education which should be emphasized in every engineering class.

The present status of the committee shows a fair record of completed standards in a tough time. There are over 100 standards completed in over 20 subjects. These are available to all industries without cost, at the Office of the National Chairman, NASC, care of the Aeronautical Chamber of Commence, Shoreham Building, Washington, D. C., in form for blueprinting. Present projects include dimensional standards for sheet, bar, tube, wire and structural shapes in both steel and dural; plain, loose and press fit bushings; acme screw threads; screw thread parts; self-aligning bearings; control rod and cable fittings; standards for surface roughness or machine finishes; low tension electrical cable; bonding; hydraulic fittings; electrical terminals; decimal methods for dimensioning drawings; high strength bolts and nuts; quick-disconnect fittings for pipe lines and cables, etc.

There are a number of Army, Navy and combined Army-Navy standards for parts and prefabricated materials as well as a fairly complete set of material specifications. Most of these are being periodically revised to keep up with the rapidly changing material situation, and in this there is an increasing liaison between the members of the Army-Navy Aeronautical Board, the NASC, the Aircraft Scheduling Unit of the War Production Board and the representatives of the ferrous and nonferrous raw material manufacturers. The dimensional standards recently completed will effect a simplification of design practice as well as manufacture and procurement. Interchangeability of raw materials between plants of prime and subcontractors is a major prob-


# CALLED FOR ACTIVE DUTY ON THE PRODUCTION FRONT



● We have a new job—to keep grinders going full blast all over the country in every war industry — in machine shops, tool rooms, experimental laboratories, repair departments, arsenals.

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Our complete facilities are now devoted to making CHICAGO Mounted Wheels and Vitrified Grinding Wheels 3" and under in diameter. We're proud to be given this definite and important part in the War Program. Our work goes on night and day supplying these vital aids for Victory.

Send us your priority orders for mounted and unmounted grinding wheels up to and including 3" in diameter. You will get the right wheel for the job—when you want it.

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lem, and here the standards are truly drastic.

This field alone, of simplified stocks of raw materials having been initiated by the NASC in anticipation of war government requirements will continue to be a major project of the NASC and will produce excellent handbooks of design data for sheet, bar, tubes, wire, rolled and extruded shapes not available now, but in process. These standards have been rapidly developed, requiring frequent revision, which is the best procedure for an industry in a period requiring so rapid change. The ferrous standards were sponsored by Eric Dudley, materials and standards engineer for Curtiss-Wright.

Incidentally, Mr. Dudley's excellent work on this project is largely responsible for his election at the November meeting to be national chairman of NASC for the year 1942-1943. His work is really just begun, for there will be many material changes before this war is won by our side.

The aluminum alloy standards were sponsored by C. T. Torresen of North American Aviation, California, who has completed a year as Western division chairman. Both of these projects required the compilation of the alloys and dimensions called for on the present and new design airplanes, individually by contractors, with the separate itemized amounts used as well as the location of the material in the airplanes. It was always necessary to show the WPB and the mill producers just where the material is now used in the airplanes, and why such is best suited. The omnipresent requirement for lowest design weight on an airplane permits little compromise with ill-advised reduction of choice of stock dimensions, but the number of stock sizes of material had to be reduced. For example, 2,700 alloys, diameters and wall thicknesses of aluminum alloy tubes were reduced to approximately 300, and others in similar proportion. Rolled or formed shapes from strip may be substituted for extruded shapes, the former produced from 50 to 100 times as fast as the latter.

Engineering departments are just beginning to develop the facility of intercompany design of subassembly parts such as tab controls, rudder pedals, pilots' control wheel, hydraulic cylinders, landing gear parts, throttle and other lever controls, pilot seats, and all such parts which each prime contractor must spend valuable time to design. These should be assigned to an NASC subcommittee to design for the whole industry. The majority are able to use such standards with little or no rework, and the more this is practiced the better will be the designs. The advantages are carried into every phase of manufacture, but especially to the field service depots in isolated places, which alone requires that the standards engineer should be a man of high position in his department. He must be able to discern good design, alert to the limits of the project, open minded to the opinion of others, a diplomat in committee and at home, and especially aware of the developments of other industries which may be adopted in his own. The work of a competent standards engineer will relieve the project and group engineers of much detail, permitting such men to devote an increasing amount of time to new principles and problems begging attention. The group designers may well demand that all non-confidential parts be developed by standards for all companies, in order to have the time for the newer problems. The parts and accessory manufacturers are literally begging for the chance to tool for large production of such items.

For the future, the field of the standards engineers, who are the NASC, and who thus represent their engineer-

(*Turn to page* 355)

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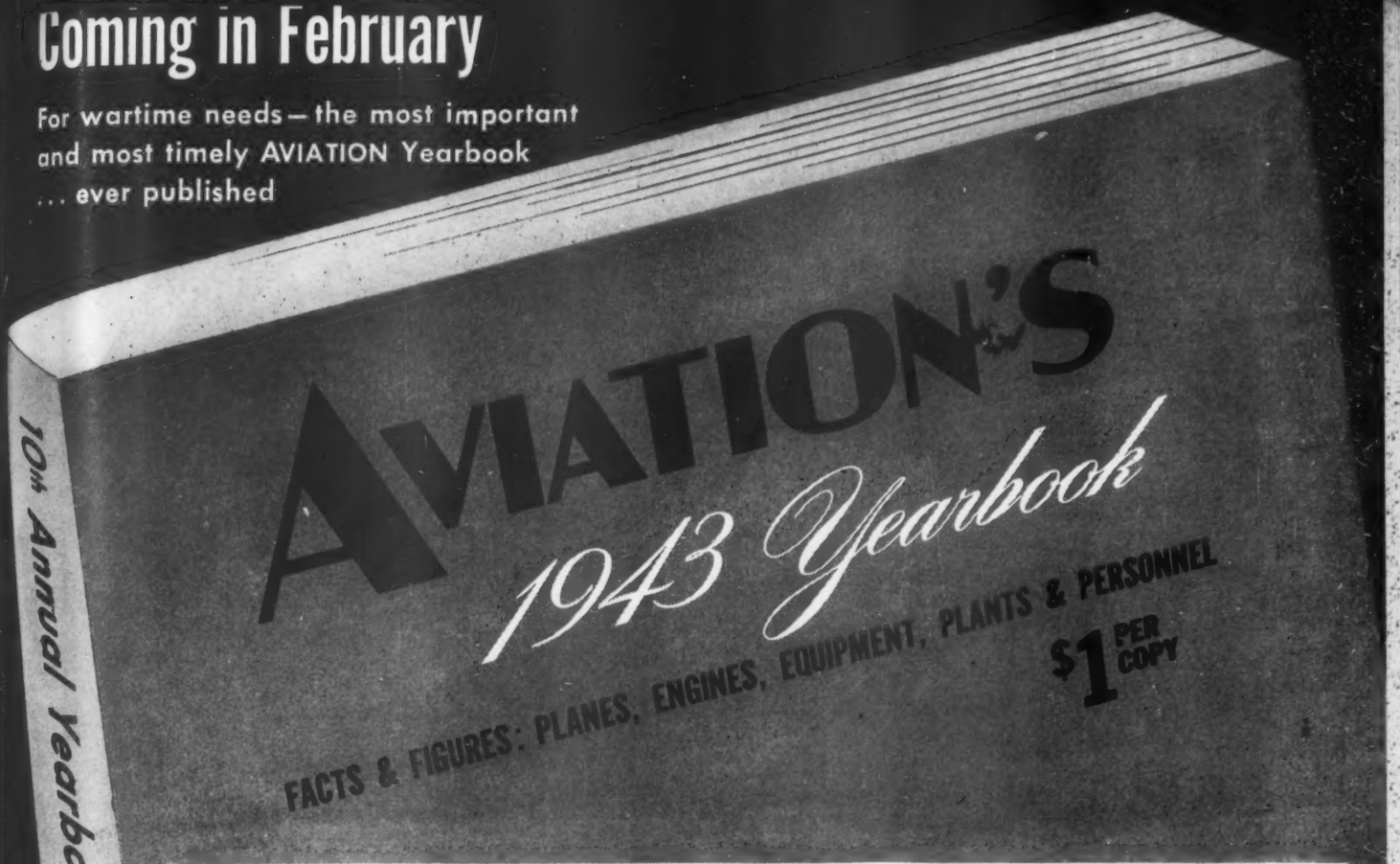


This year, as never before, *Aviation's Yearbook* of essential working information will be welcomed by the men responsible for our ever-increasing air supremacy.

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Keyed to war speed, *Aviation's Yearbook* is edited for those whose business is aviation . . . and doubly valuable to the thousands of newcomers to this fast-moving industry.

Index to the value of the *Yearbook* is last year's demand for more than 17,000 copies at $1—over *and* above regular mail distribution. Total distribution of the *1942 Yearbook* ran well over 50,000 copies.

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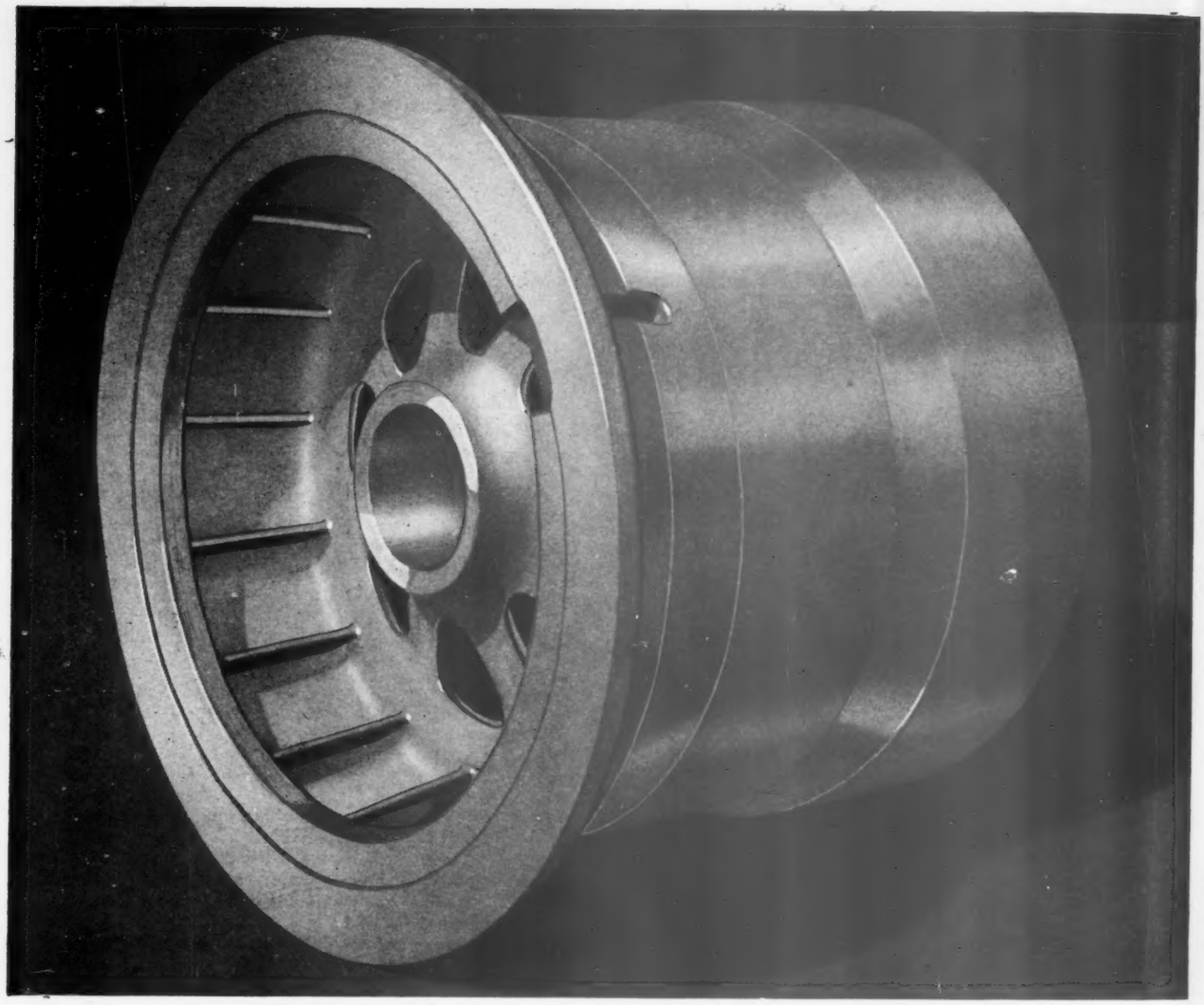

# AIRPLANE WHEEL OF MAGNESIUM (Dowmetal)

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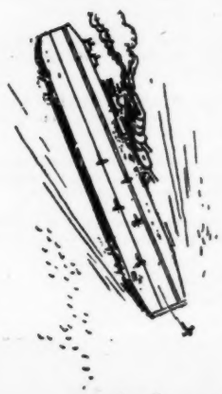

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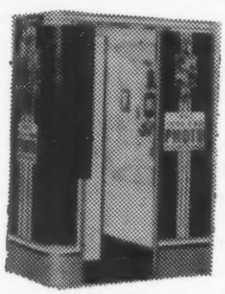

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INTERNATIONAL MUTOSCOPE CORPORATION

*Established 1895*

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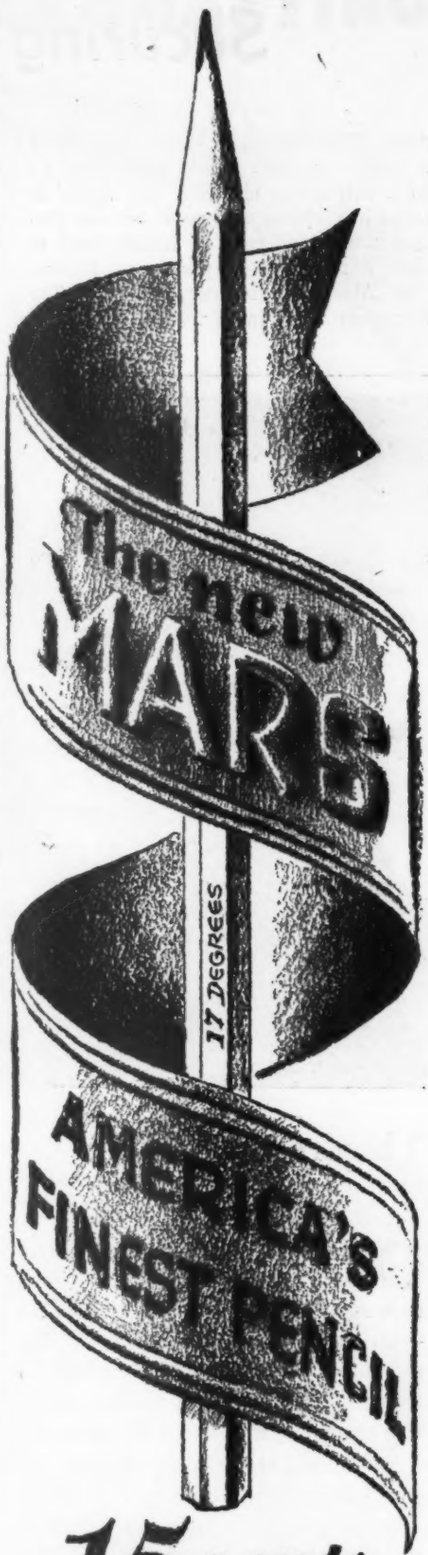
(*Continued from page* 352)

ing departments, is pregnant with possibility and responsibility. Given good standards for screw thread products, structural shapes with adequate stress data, more adequate bearings, methods for attachment for skin and structure, etc., with adequate sources of supply with reliable cost data, designers will be largely free of detail design with much more time for new problems, which is the proper work of the group designers and their leadmen.

This nation entered this war with almost no preparation for interchangeability, which requires highly skilled men. For example, Germany, already far advanced in the knowledge of economical interchangeable design, used 3 types of landing gear, compared with 27 in the United States. Early in the war, one contractor arranged with another to use the latter's main landing gear assembly. This assembly was designed and used on a medium bomber and was adopted by the second contractor to an airplane of different design and purpose. This is considered unusual in this country, but will be considered a blessing from heaven when the second airplane begins to reach the same advanced supply bases in actual combat. Project engineers may do much of this same thing, and thus do much to maintain more airplanes in the air rather than on the ground for lack of spares. When the days of peace come again, and the need to build for economy of manufacture and serviceability, especially in the foreign countries where we expect to send American airplanes, the work of today's standards engineer will be advantageous. Standardization belongs to no one period or condition of war or peace.

With respect to new design, the National Aircraft Standards Committee may become the heart of the Aircraft Engineering Society which we shall have, but do not have now in America. This society should include all of the Americas. By such organized liaison, a survey may be made quickly of the best shock-absorbing bearings for landing gear, means to rotate main landing gear wheels, control pedestals and accessories, flap and dive break mechanisms, gun slot closures, sleeping berths and air conditioning systems, and so on, as fast as new requirements develop.

The requirement of the project engineers for the new standards should bring out every process and method of manufacture which has advanced beyond the secret experimental stage. The willingness to share has been stimulated, and in our opinion will not be lost to the engineering departments represented on the National Aircraft Standards Committee.

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# Securing Means for Air Cargo*

By COL. E. S. EVANS
*President, Evans Products Co.*

AIR TRANSPORTATION of freight is today a reality. Forty percent of all LCL shipments made by the Army is made in airplanes. I need not tell you that the major part of freight sent to such out-of-the-way places as Iceland and Alaska is moving by air. The transport from India to China, conveying supplies to Chungking, is moving larger quantities of freight than did the 4,550 trucks on the Burma Road. Just what is being carried to England by the bomber ferry is the Army's secret.

In spite of the above facts, there has been up until now no scientific method of shoring and stowing cargo in freight planes. This is not at all surprising because I can remember some 27 years ago, when I was carrying on a series of experiments which led to the adoption of scientific methods for the loading of automobiles, that automobile engineers would not even consider their loading problems. They were too engrossed in design and all of the difficulties of giving birth to that great industry.

When the matter was raised, I was referred to the loading foreman on the dock and these men each had their own individual ideas, none of which were based on scientific research, with the result that there were 18 distinct methods of loading automobiles in force in 1915. This held true for a number of years after that until, through constant urgings and some education, the automobile engineers commenced to take an interest in the car after it was built to see that it arrived safely at its ultimate destination.

It was in those early days that, carrying on a series of intensive scientific experiments, I laid the foundation for the adoption of loading methods for automobiles which has since that time reduced railroad damage claims $5 per automobile to 8 cents per automobile and which, in addition to about 300 million dollars saved the railroads, has saved the automobile companies and dealers another 300 million dollars.

The loading of various commodities of box cars is supposed to be regulated by rules published by the Association of American Railroads and sponsored by a Loading Rules Committee, but to an engineer some of these rules guarantee not safety to the cargo but damage to the cargo and show an astonishing lack of scientific knowledge of the problem which would, on the face of it, seem to be a simple one. As an illustration of what I mean, a load of linoleum was fastened in a box car with the Evans Utility Loader and arrived in perfect condition; a similar load made in accordance with the loading rules of the Association of American Railroads in which the cargo was fastened with band iron suffered considerable damage. Hot rolled band iron will stretch 15 per cent before it

(*Turn to page* 359)

* Paper presented at the Air Cargo Engineering Meeting sponsored by the Chicago Section of the Society of Automotive Engineers, with the cooperation of the SAE Aircraft Activity, the Air Transport Association of America and the Aeronautical Chamber of Commerce, Dec. 8, 1942.

HERE'S HOW TO ENLIST YOUR BINOCULARS

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The Navy is not authorized to accept gifts or free loans. Therefore, the binoculars are purchased for $1.00 and if they are available after the war they will be returned to the owner, in which case the $1.00 will constitute rental and appreciation charges. Commanding officers of naval vessels are requested to notify you of the ship aboard which your binoculars are in service.

They're in the Navy Now

ON the bridges and look-out stations of American ships, brave men stand alert, searching the horizon —on guard against enemy attack. You can help these men, and thus help to hasten the day of Victory, by sending them your binoculars for the duration.

Binoculars are among the many optical instruments of war that Bausch & Lomb is producing and helping others to produce. Today, even with a twenty-four hour day, and vastly expanded production program there is not room enough, nor time enough, to turn out all of the binoculars the Navy needs.

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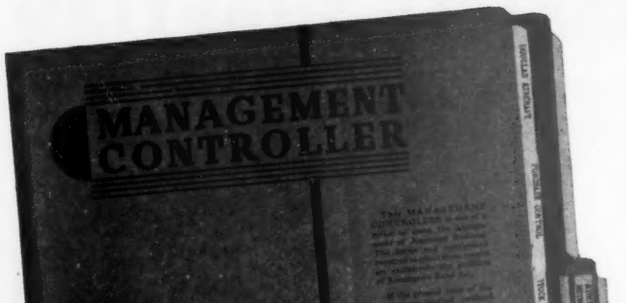
## FLEXIBLE SHAFTING

FOR REMOTE CONTROL AND POWER TRANSMISSION



# YOU MAY EXAMINE THIS MANUAL FREE OF CHARGE

★ **This book is for aircraft manufacturers and sub-contractors who are seeking more effective methods for expediting production. It is not advertising "literature". It provides a thorough, clear cut analysis of the records, routines, and equipment employed today by more than thirty famous aircraft producers.**

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**Because of the confidential nature of much of its material, this manual can be delivered only to qualified aircraft executives and their staffs. It is offered on a loan basis only.**

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*Another Kardex Production "Expediter"*
*by* **REMINGTON RAND INC.**

(*Continued from page* 356)

fractures. Therefore, a cargo stowed in one end of the freight car with band iron, each piece of which is about 20 ft. long, is susceptible of stretching about 3 ft.

I found in tests made with automobiles, in which we used three freight cars on the middle one of which we placed an automobile fastened to a dynamometer, that where the loading blocks were pressed tightly against the wheels we got entirely different results from where they were pulled back a half inch. Where the blocks were drawn back from the tires and the car shunted into other freight cars, the blow exerted on the blocks and on the dynamometer was four times as great as it was when the blocks were fitted snugly to the contour of the tires. Therefore, we were able to evolve certain principles in loading which later experiences developed to a point where they became the fixed formula.

For instance, we find that in freight cars practically all damage is caused by one of two things. Either vertical vibration which, at its extreme, is called harmonics, or longitudinal shock. This is only of interest to you because millions of dollars worth of airplane parts are shipped in freight cars and, whereas it has no direct bearing on airplane cargo loading, it is nevertheless important that we get a grasp of the broader problem before applying it to the specific question under discussion. Whether a load is made in a freight car, in a truck trailer, or in an airplane, there are certain basic rules which have to be followed. The prime rule is that there must be no slack in the load. If the load can move, immediately its own momentum will set up stresses and shocks which will enable it to break its moorings, shift center of gravity, and do many other dangerous and hazardous things.

In most instances, cargo carriers today in the air are converted passenger transports or bombers, and no provision of a permanent character has been made for cargo shipment. The very nature of the structure of an airplane is such that it is difficult to fasten heavy objects in such a way that they will not tear through the aluminum sheeting, and so the engineering of airplane loading offers difficulties that are foreign to loads in freight cars or truck trailers. However, where transports are originally designed and built for freight transport, this is no longer true. Strong, securely fastened loader parts can be incorporated into the design of the ship so that hold down members of various types can be attached without danger of injury to the hull of the ship itself, and individual commodities of considerable weight, such as airplane engines, reels of cable, large machine tools, etc., can be loaded with perfect safety and security.

The one thing that the loading engineer has to consider as the prime factor of airplanes is weight. In a box car we put equipment that weighs 9,000 lb. In a plane, carrying almost as large a load, the equipment will weigh less than 3 per cent of this amount, or a maximum of less than 300 lb.; and in such planes as are ferrying freight to Alaska, the loading materials used for fastening down a whole cargo is about 100 lb. Therefore, the greatest care in design to accomplish lightness and, at the same time, ample strength has to be employed. Materials must be used that will insure a tight and resilient fastening and that will not stretch under impact. It is not unusual for a down draft to be violent enough to lift the entire cargo so that it will exert an upward strain of 2 to 4/10 times its own weight. If the cargo is not held

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THE SAFE SKIN HOLDER

PRESTITE—Prestole's latest achievement in the aircraft field—skin holders that are both *safe* and *easy* to use in assembling aircraft skins.

PRESTITE fasteners will not only speed up production but their "Safety First" feature (note solid integral head which holds pin safely in position), will eliminate the danger of "letting go" and injuring workmen.

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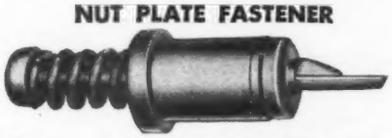

Prestites are doing an outstanding job in pre-locating nut plates. Their alignment feature centers the nut plate, and the holding pin is so formed as to prevent damages to threads or fibre inserts.

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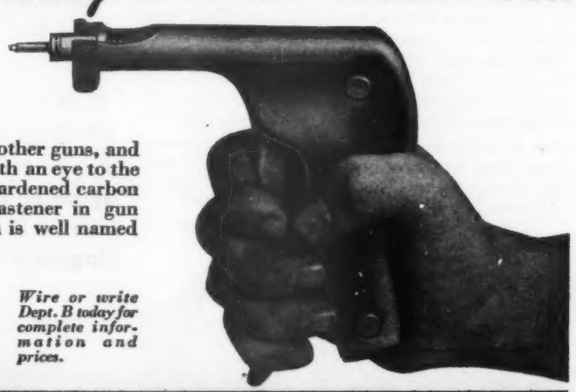

Almost *half* the weight of other guns, and designed to fit the hand, with an eye to the feminine users. Separate, hardened carbon steel holding ring locks fastener in gun during assembly. This gun is well named the "Safety Champ."

*Wire or write Dept. B today for complete information and prices.*

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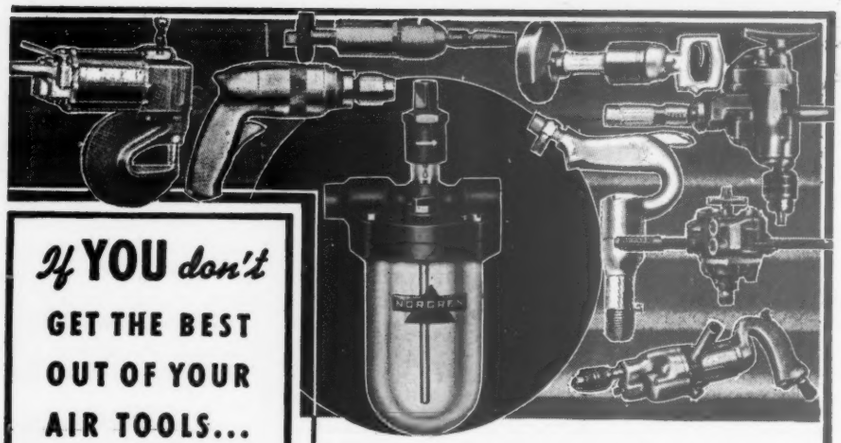

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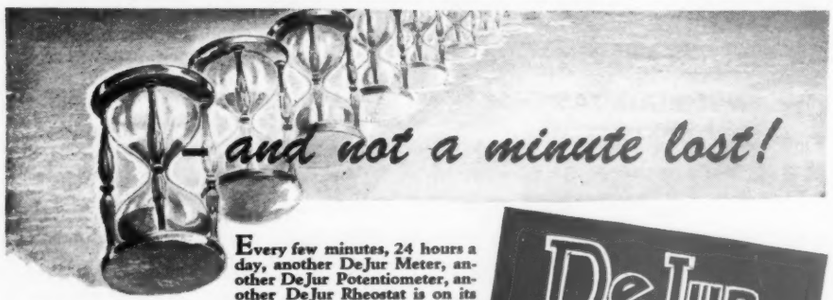


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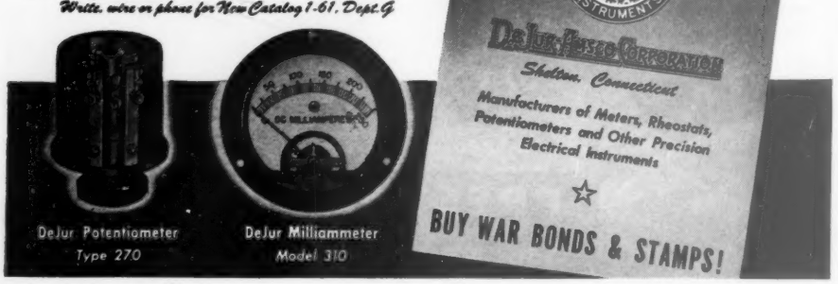
**Out of all this—with your help and ours—will come final victory. Equally important, will come new developments, new discoveries that will far transcend anything in the past.**

*Write, wire or phone for New Catalog 1-61, Dept. G*



securely and the plane should wobble, the whole cargo could be thrown off center and the center of gravity changed to such a point that the plane would crash.

Airplane efficiency can be greatly increased if proper loading is practiced. For instance, there are many objects that are shipped in airplanes today where the box weighs as much or more than the article it contains. Crates and boxes are often bulky and unnecessarily heavy. If proper loading materials are used, the weight and space occupied by heavy crates and boxes can be replaced with unboxed or very lightly boxed commodities and the payload greatly increased. Proper loading materials will accomplish this safely and quickly.

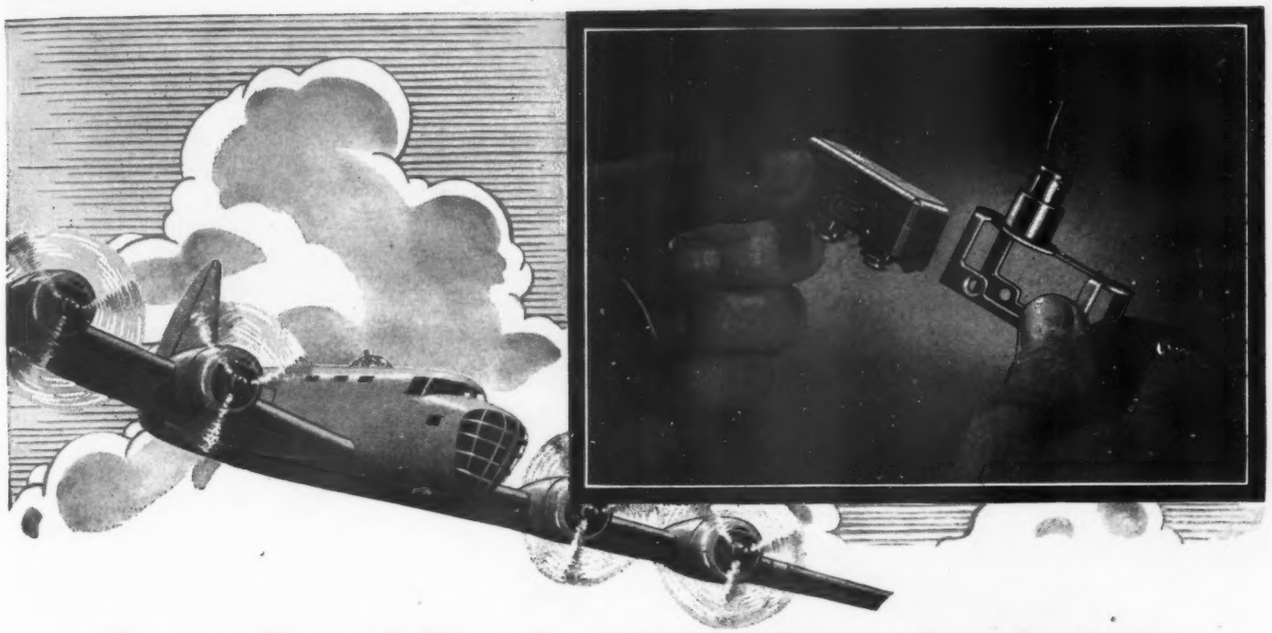
An excellent illustration of what I mean is a load of airplane engines shipped in box cars. I use this only as an illustration, but it will relate in a lesser degree to airplane engines and other parts shipped in air freight transports.

Until recently, the airplane engine manufacturers were purchasing heavy wooden crates weighing hundreds of lb. and costing $77 for the shipment of their engines. A box car load consisted of seven engines, and this box car only carried a payload one way, being shipped back with empty boxes which could be salvaged. A load made in an Evans Utility Loader, which is similar in its functions to the materials that we furnish for airplane cargo, took 14 engines and eliminated the cost of $77 per crate, the freight on 12,600 lb. of boxes, and the labor of boxing and unboxing the load at the two ends of the trip. The saving showed $1,176 per trip, and in view of the fact that it is expected that we will ship many thousands of engines a month in 1943, there would be a saving of approximately $2,525,000 a month which is now total waste.

The same general rules hold as true with air freight as they do with box car freight, and a study of the various loads now being made by you gentlemen will probably disclose many ways that the vital things shipped can be increased at the expense of unnecessary dunnage.

If you know that each part of the cargo will be held firmly and securely in place and will have no chance to bruise or injure itself by hammering or rubbing, you can safely lighten the packing and crating accordingly.

Most of the present devices have been designed to be used in converted planes built originally for some other purpose and, therefore, they are more or less make-shifts as compared to what the final holddown or loading device will be.



# *Four Good Reasons for Standardizing on These Micro Switch Actuator Brackets*

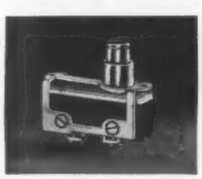
**Designed to Carry the Air Corps Approved Type R-31 Micro Switch . . .**
**For Complete Details of This Switch, Refer to Our Aircraft Catalog No. 70**

**These actuator brackets require no deviation permit as they are considered a part of the aircraft.**

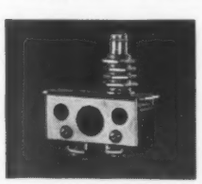
**They are all specifically designed to accommodate the Type R-31 Aircraft Micro Switch.**

**Their use permits faster and easier installation of the Type R-31 Aircraft Micro Switch.**

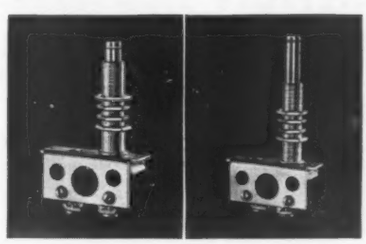
**They make field replacement of Type R-31 Aircraft Micro Switch easy without disturbing bracket.**



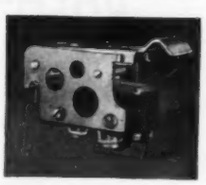
This new Type M-B skeleton bracket saves weight. It is complete with overtravel plunger and is interchangeable with Army switches A-1 and A-2. Weighs only .128 lb.; .02 lb. less than Army switches A-1 or A-2. The plunger on this bracket has a definitely controlled pre-travel and overtravel—a total of ¼". The Type R-31 Aircraft Micro Switch is sturdily supported in this skeletonized bracket by flush headed screws with lockwashers. The mounting holes in the top of the bracket are on standard $1\frac{13}{16}$" centers and accept No. 6-32 bolts.



The Type M series of panel mounting brackets offer three lengths of threaded stems for easy positioning by hex nuts and lockwashers. Switch operation takes place in the first $\frac{1}{32}$" of plunger travel. Over-travel ¼" or ⅜" beyond the point of switch operation is provided. The Type R-31 Aircraft Micro Switch is carried on two thru-bolts as shown in the illustrations.



The Type T series bracket has met instant adoption as a throttle warning switch, singly or in gangs. They are operated by cams on the throttle quadrant or dogs on the cables. Any switch held depressed can be instantly opened by the manual release without disturbing others in the gang. As a general use limit switch the Type T bracket without the release is a sturdy mount and actuator for Type R-31 Aircraft Micro Switch. Two thru-bolts make replacement easy.



The Type H series of aluminum housings, one of which is illustrated here, are complete with a plunger actuator which can be sealed against splash, dirt and oil. It is fitted with "A-N" outlet fittings, either straight or adjustable to 45 degrees. The plunger over-travel beyond the point of switch operation is ⅜" on the Type H and 1¼" on the Type HO3. The Type R-31 Micro Switch is easily installed on two mounting pins within the housing.

Data sheet No. 27 gives full engineering data on the series M brackets.

*Micro Switch is a trade name indicating manufacture by Micro Switch Corporation*

**Catalog No. 70 furnishes general data on switches for aircraft. Ask for as many copies as you need**

# MICRO MS SWITCH

*Manufactured in FREEPORT, Illinois, by Micro Switch Corporation*

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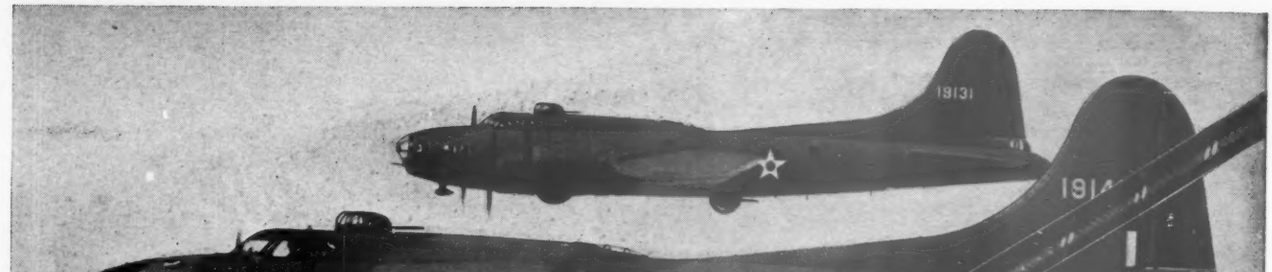

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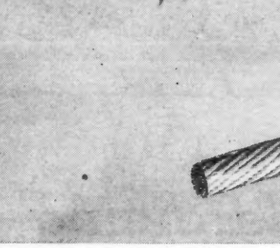


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Modern aircraft's rigid requirements for power and lighting cable are more than met by Belden's new low tension wire with Balanced Insulation. Every characteristic essential to this service has been taken into account. Belden Primary Wire has been approved under AN-J-C-48 specifications. It is:

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# Belden *Aircraft* WIRE

**Starter, Lighting, and Instrument Cables √ √ √ SPARK PLUG WIRES**

# Designing Better Cargo Planes

**A discussion of the deficiencies of converted passenger airplanes for cargo transport and future desirable operating requirements.***

By CHARLES FROESCH

*Chief Engineer, Eastern Air Lines, Inc.*

ONLY TEN MONTHS have elapsed since the airlines of the United States were called upon to begin the transportation of cargo on a large scale for the military services. The volume of cargo so far flown and its rate of daily increase have presented cargo handling and transporting problems which must be satisfactorily solved before air cargo transportation can become a routine operation.

Expedient solutions are meeting the present emergency but fundamental thinking and reasoning must be followed to derive specifications applying to cargo airplanes in order to establish the transportation of air express and air freight as a commercial business at the termination of the war.

Flying has become an accepted means of transportation by the commercial traveler as well as the vacationist but the carriage of goods by air has lagged primarily because of the lack of suitable flying equipment and handling facilities. Furthermore, the relatively small amount of space available for air cargo has been indirectly the cause for the existing high tariffs which, in most instances, have been higher per pound per mile than comparative passenger rates.

When it became obvious at the beginning of this war that speed of transportation for critical military materiel was essential, it was logical that available passenger equipment in use, or already designed and ready to be produced, should be quickly altered to meet this immediate demand.

The result was that airline equipment was pressed into cargo operating service literally overnight and speedily converted for such service by the removal of all passenger accommodations, strengthening the floors with additional covering and changing the radio equipment to meet military requirements.

This conversion was effective, although rather inefficient insofar as maximum ratio of useful load to gross weight is concerned, but this was partly offset by lifting commercial weight restrictions and increasing takeoff weights in the order of 20 per cent with surprisingly safe and reliable results, which incidentally, emphasize the conservativeness of commercial equipment maximum operating weight ratings.

The standard Lockheed *Lodestar*, Douglas DC-2 and DC-3 transport airplanes were thus modified and are doing an excellent job. Later on, production of the C-47 which is basically a DC-3 cargo version having a large side loading door; the C-46, a modification

* Paper presented at the Air Cargo Engineering Meeting sponsored by the Chicago Section of the Society of Automotive Engineers, with the cooperation of the SAE Aircraft Activity, the Air Transport Association of America and the Aeronautical Chamber of Commerce, Dec. 8, 1942.

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**FOOLPROOF**—Set resin is non-crazing, has good gap-filling qualities. Makes strong bond on joints where perfect fit may be difficult or impossible to attain.

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of the original 36-passenger Curtiss-Wright CW-20 commercial transport airplane; and the C-54, a conversion of the production DC-4 airplane, swelled the ranks of cargo airplanes to expedite movements of military personnel and materiel. A more recent modification was that of the Consolidated B-24 four-engine bomber to long range cargo carrier and known as the C-87.

While the following discussion covers the deficiencies of all these airplanes as applied to air cargo operation, it must be remembered that none of them were designed strictly as cargo carriers or for conversion to air cargo transportation and, therefore, none of these criticisms and shortcomings can or do reflect, in any manner, on the equipment manufacturers themselves.

In the first place, no one knew just what a cargo airplane ought to be and with limited airline experience in cargo operation, much difference of opinion still prevails on the characteristics and specifications involved in the design of this type of airplane.

However, we are fortunate to be in the same position as the beginner photographer who is proverbially taught how to take bad pictures in order to learn how to take good ones.

Let us, therefore, analyze the deficiencies of these converted airliners and outline suggested modifications for future equipment in the light of our limited operating experience.

First of all, we find that the conventional type of landing gear renders loading of the cargo compartment with heavy cargo pieces difficult because of the floor gradient. This is aggravated by the lack of anchor points for hoist attachment to help pull heavy items at the entrance door or in the cabin. Also, that in order to have a necessarily horizontal floor in the region of the loading door, the main floor makes an angle with it and causes concentrated loading when handling heavy long pieces of cargo with resultant floor damage.

Second, we find that the standard passenger cabin floors are too weak to stand concentrated loads as well as the rough usage to which they are now subjected as cargo carriers. This has demanded their reinforcement by either strengthening the present floor structure or covering it with an additional floor. This supplemental floor consisted generally of plywood sheeting $\frac{3}{8}$ in. to $\frac{3}{4}$ in. thick and has been found quite serviceable although it substantially increased the empty weight.

Third, we find that in the converted airliners, the cabin entrance door is too narrow and too low to take the bulkier cargo pieces. This restriction seriously impedes efficient loading and unloading and limits the size of cargo pieces which can be handled. This is an important item when it is considered that the size of cargo pieces may commonly run from an article so small as to require wrapping its shipping label around it instead of pasting it, to automotive units measuring almost 13 ft. in length, $6\frac{1}{2}$ ft. in width, $4\frac{1}{2}$ ft. in height and weighing 2500 lb. Occasional loads either have greater dimensions and/or weight. It would be desirable to have an additional door, located opposite, to enable simultaneous loading and unloading and thus save time on the ground, particularly when one or two pieces of a load are difficult to handle, either due to size or weight.

Fourth, we find that when we have placed the cargo within the airplane in its proper location, no means are available to anchor the tie-down cables, ropes or other devices used and a makeshift installation must be provided.

Each type of cargo presents a somewhat different problem in tie-down procedure. Methods of tie-down vary with individual airline interpretation due to lack of basic provision in the airplanes. Some airplanes have ring tie-down fasteners attached to the floor

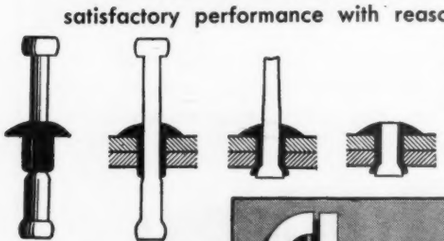
(*Turn to page* 367)

STEM HEAD
THE STEM DOES THE WORK IN A
STEM
CHERRY BLIND RIVET
RIVET HEAD
RIVET SHANK
Positive head formation and shank expansion produced by rivet stem. No bucking bar needed
PLUG SECTION OF STEM
BLIND STEM HEAD

The Cherry Rivet is designed to do a first class riveting job in the blind or hard-to-get-at places in aircraft structures. This rivet is actually an assembly, consisting of a standard aircraft rivet which has been drilled and through which passes an aluminum alloy mandril or stem.

***SPECIAL GUNS USED***—The rivet can be placed in the work first or the projecting stem can be placed in the gun head and then inserted in the work. The gun may be either a hand-operated or power tool. (Head of the G-15 Pneumatic Gun is shown above.) In either case the gun pulls on the stem and pushes on the rivet head. As the stem is pulled through the rivet it forms a tulip head on the blind side, expands the shank of the rivet and permanently plugs the rivet. The pull continues until the stem breaks and frees the gun. The stem is then trimmed flush with flat ground nippers.

***FAST OPERATION***—Cherry Rivets can be applied at the rate of 800 to 1600 per hour depending upon the type of rivet used. They give satisfactory performance with reasonable tolerance in grip length and hole size. Complete instruction on Cherry Rivets and their application furnished on request.



Mandril in the self-plugging Cherry Rivet, when pulled by special gun, forms a tulip head, expands rivet shank, permanently plugs the rivet and then breaks, releasing gun. The mandril is trimmed.

MANUFACTURED UNDER U. S. PATENT NO. 2,183,543 AND OTHER PATENTS PENDING

**Cherry Rivet** *Company*
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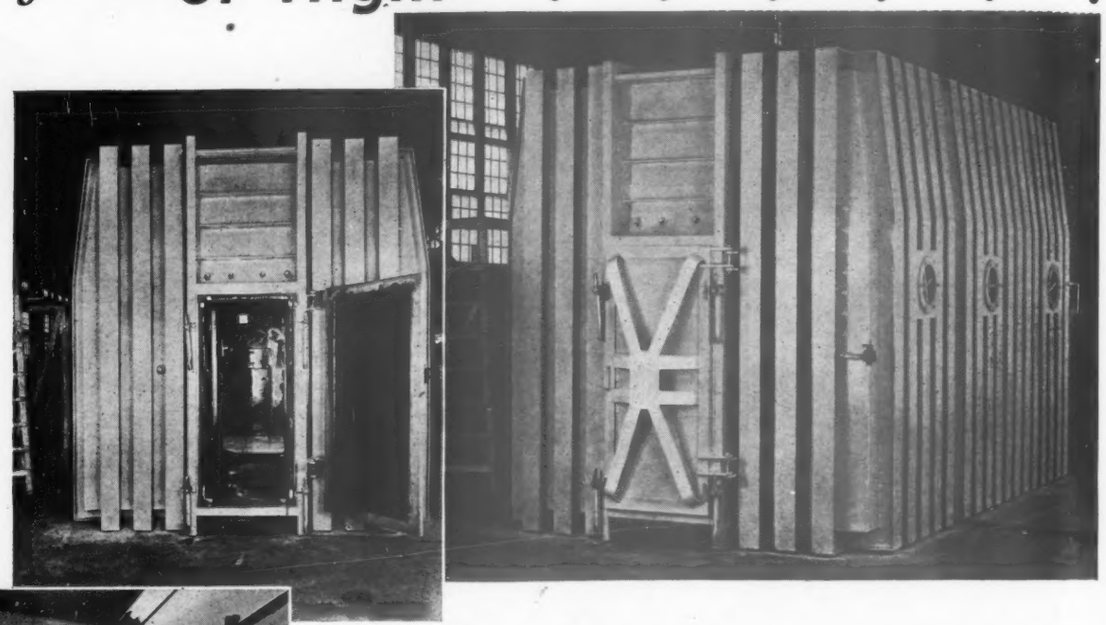

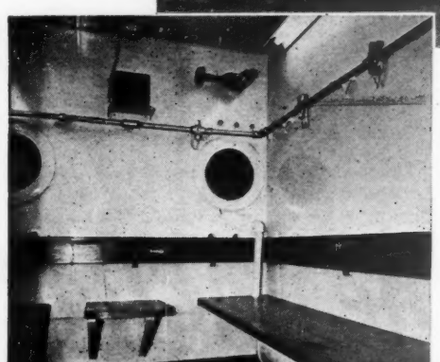

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(*Continued from page* 364)

frames, others have side rails and still others employ a combination of both means. The most common practice is to use ropes tied in an indiscriminate manner, usually following the fancy of the handler lashing the cargo. Nets are used but need frequent replacement.

Many ideas are being tried and each particular type has its own merits and drawbacks. No matter what tie-down means are successfully developed, their satisfactory application will depend primarily on the proper training of the loading personnel in their use.

Fifth, we find that no provisions are readily available for a cargo handler station.

Sixth, we find a lack of simple and concise information to permit the loading personnel to accurately distribute the cargo load within the prescribed balance limits. In addition, it is often difficult to place heavy pieces within the cabin and still retain a center of gravity location which will not seriously affect longitudinal stability as well as takeoff and landing characteristics.

For instance, when a load of 6,000 lb. is carried in the C-49, its CG must be at a point, roughly, 28 per cent of the cabin length measured from the forward cabin wall. This seriously limits the available placement volume if the cargo is bulky.

The arrangement of cargo is at best a process requiring intelligent action in view of the variable weight, size and type of cargo pieces, besides the fact that such cargo may be bound for several destinations requiring placement in the compartment to allow sequence unloading.

Loading requires the coordinated effort of the plane crew, ground operations, loading personnel and, when in flight, communications to keep station delays due to loading and unloading at a minimum.

Seventh, we find that the lavatory compartment is in the wrong place as it is often difficult, in flight, to reach it from the pilot's cockpit with an airplane fully loaded with bulky material of low density.

Eighth, we find that no provisions are available for fire detecting and extinguishing in the passenger cabin converted to cargo compartment as hand fire extinguishers are the only requirements for passenger operation.

Ninth, we find that each type of airplane has a different doorsill to ground height, necessitating lifting or lowering the cargo when loading from a standard motor truck platform height. This has resulted in serious delays, trip cancellations and inability to operate on schedule. For instance, the doorsill height from the ground is but 3 ft. 6 in. for the C-87, whereas it is 9 ft. 8 in. for the C-54, or a difference of 6 ft. 2 in. between the two.

It has necessitated the use of makeshift devices such as loading ramps to enable transfer from standard truck platform height.

Tenth, we find that the cross section of the fuselage, usually of circular or oval shape, does not permit maximum space utilization.

These are ten primary deficiencies found in the operation of converted passenger transport airplanes for air cargo service as well as in airplane originally designed for passenger operation and factory modernized for cargo carrying.

While our primary purpose at the present time is to win the war, we must, nevertheless, look deeper and make plans for the future, or at least try to conceive what air transport operations are likely to be afterwards. Naturally, whatever changes are made by following this line of thought will also apply to military cargo airplanes with the exception, perhaps, of speed, which for military purposes must remain more important than operating cost.

In thinking of the progress of air transportation and its place in our


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national system, we must try to find its proper relationship with other available surface means. Obviously, we cannot hope to fly every traveler and carry every type of merchandise with maximum economy and must, therefore, segregate passengers and cargo by purpose and distance of travel.

Before we can tentatively set down operating requirements for airplanes designed basically for commercial air cargo operation, we must first determine just what are the fundamental laws which apply to the transportation of air cargo.

The principal service the air cargo operator has to offer to the shipper is the speedy and safe transportation of his products. He must furnish this service at a sufficiently low tariff to attract and continue to carry a large volume of traffic. Air express volume has been built in the past primarily on the demand for emergency and perishable shipments which could bear a rate premium and as such can never grow to a substantial size.

Our first consideration, therefore, should be lowest possible operating cost per ton mile. This is a necessity if we desire to obtain a large volume of business and compete with other means of express and freight transport which now have substantially lower rates per ton mile from door to door than we have been able to obtain with the airplane to date.

First-class rail express is moved at a cost to the shipper at an average of ten to twelve cents per ton/mile and if this rate can be met, including pickup and delivery cost, there should be a large volume of business available for movement by air and including most commodities now going by rail express.

We certainly cannot hope, nor expect to supplant existing means of surface transport, as at one time or another in the course of modern processing or fabrication of commodities or articles, practically all such means are utilized. The airplane will probably limit its service to the transportation of merchandise representing either a high density or volume cost such as expensive tools and vacuum tubes, thus becoming intermediate means of carrying finished products from factory to consumer with maximum expediency.

A ten to twelve cent per ton/mile rate is not impossible if we judiciously interpret and apply our present knowledge of aerodynamics, improvements in structures and larger power plants to the design of strictly cargo carrying airplanes.

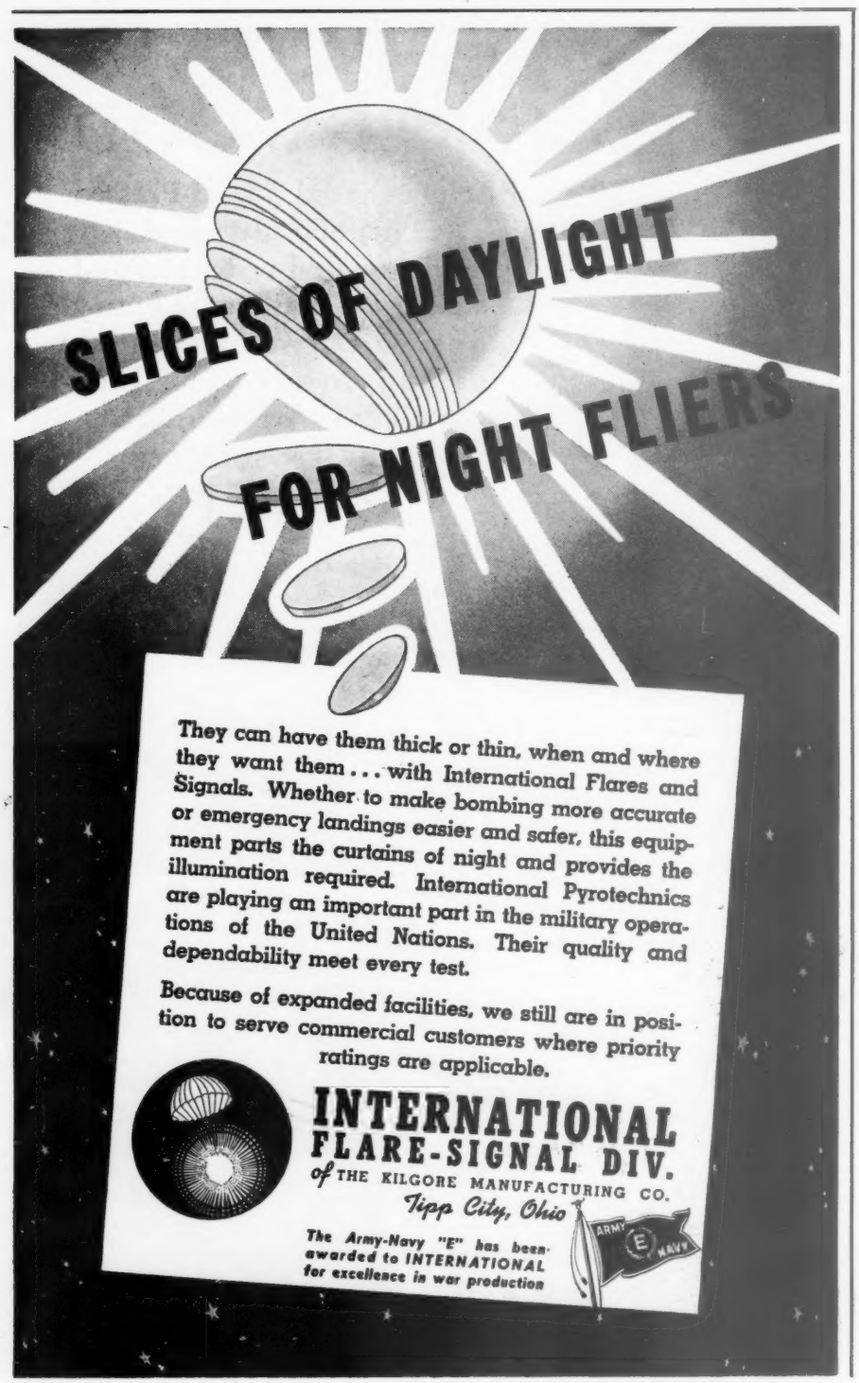
It is true that mileage from point to point is invariably lower by air and that the elimination of heavy packaging decreases cost of cargo preparation and promotes efficient utilization of the airplane, but still these advantages come far short of overcoming the differential between air and rail express tariffs.

We can possibly go further by exploring the field of LCL freight which might possibly be handled as second-class or deferred express, bearing a lower rate and used to increase the average load factor, thus reducing average ton/miles/hr. cost.

At a later date we may conceive the use of cargo glider trains with takeoff and landing strips alongside factories simulating present railroad sidings. However, this discussion is limited to operating requirements of cargo airplanes only.

A cargo airplane should be a vehicle to carry merchandise not only at the lowest possible cost, but at the highest permissible speed. High speed is essential but if it is to be obtained purely by a reduction in cruising power loading, operating costs will be higher, since speed varies as the cube root to the horsepower. This being the case,

(*Turn to page* 371)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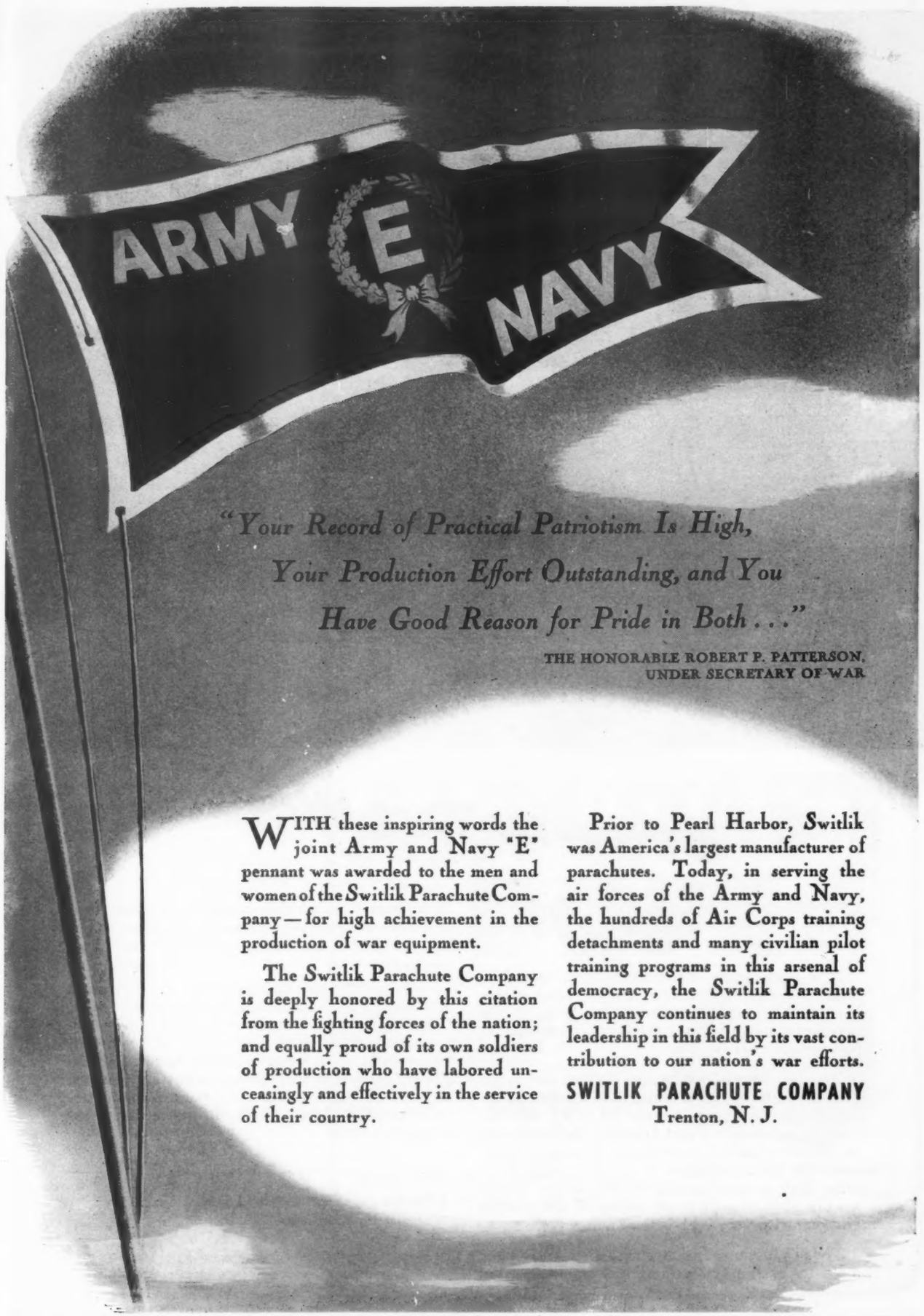


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The Switlik Parachute Company is deeply honored by this citation from the fighting forces of the nation; and equally proud of its own soldiers of production who have labored unceasingly and effectively in the service of their country.

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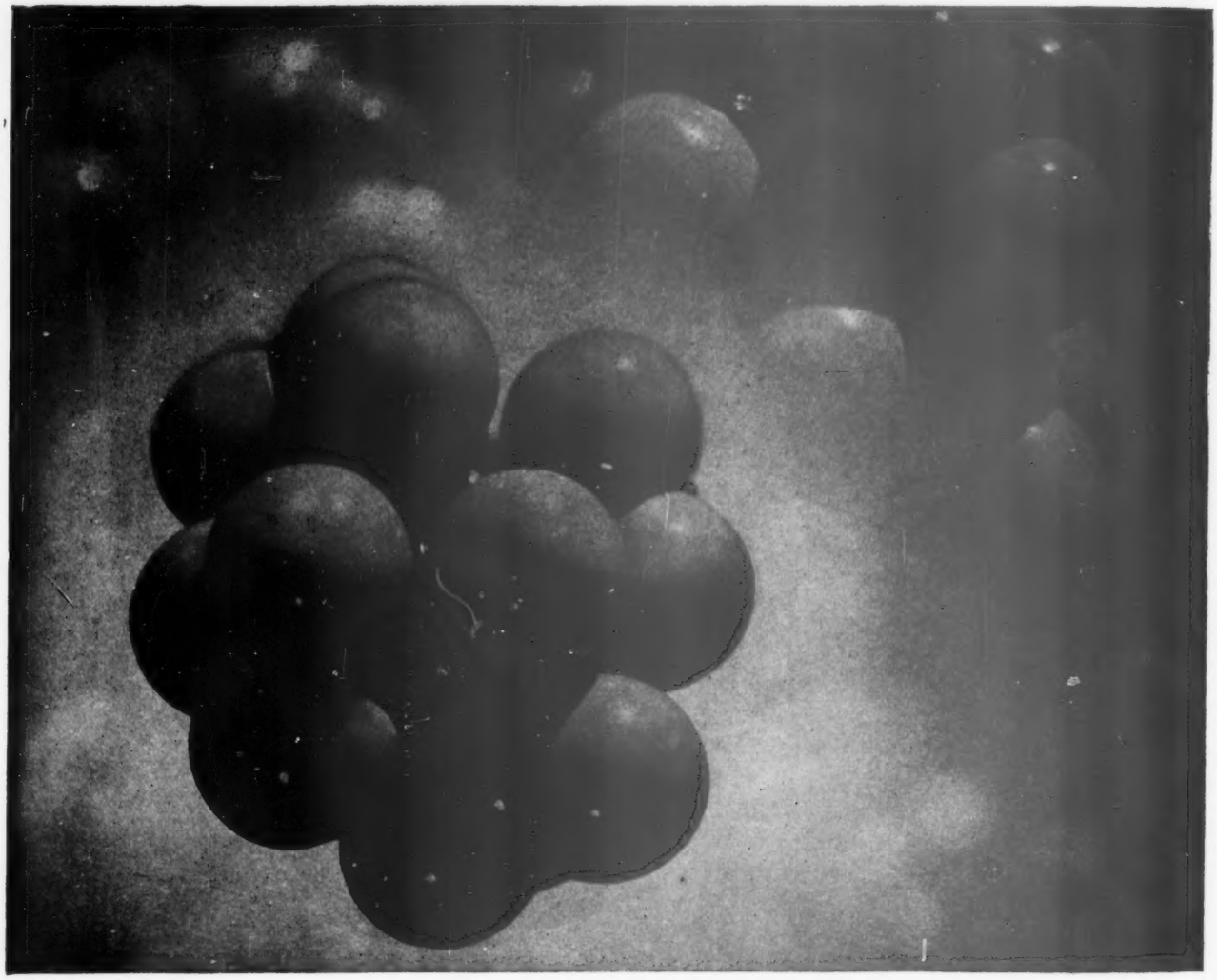

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It is a molecule—represented by a chemist's model 100 million times life size—of neo-hexane, one of the modern synthetic products of the petroleum industry that far surpass gasoline as fuel for aviation engines.

The discovery of neo-hexane (known also as 2,2 dimethylbutane) was a triumph of the petroleum industry's peacetime search for more efficient fuels. Long before Pearl Harbor, the American oil industry had discovered and developed processes for manufacturing this and a number of other high octane blending agents so that today we are able to supply all planes of the United Nations with very high octane motor fuel.

The production of aviation gasoline is no longer a matter of simply distilling and cracking crude petroleum. It is a highly complex chemical art—a science of synthesizing special compounds that can be blended into fuels of predetermined characteristics.

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Chrysler Building, New York City

*Manufacturers of Ethyl fluid, used by oil refiners to improve the antiknock quality of aviation gasoline.*

(*Continued from page* 368)

tariffs would have to be raised and volume obtainable lowered.

For a given airplane, designed for a specific gross weight, and having a given wing loading, there is a power loading which is most economical. In other words, there is a balance between maximum payload and lowest cruising horsepower on one hand, and low power loading with reduced payload on the other.

This can be readily determined with a given airplane by calculating its transportation efficiency factor expressed in ton/miles/hp./hour for several horsepower values, that is:

$$\frac{Pl \times Vc}{HPc}$$

Where Pl=payload in tons
Vc=cruising speed in mph.
Hpc=cruising horsepower

The overall efficiency factor of the airplane can be obtained by multiplying the structural efficiency expressed by operational useful load gross weight by the aerodynamic as expressed by cruising speed/hp. and plotting against range.

Obviously, there is nothing to be gained if due to high speed the cargo must wait several hours to be unloaded at destination, such as might occur with a load of perishables having left the field of origin the evening before and arrived at destination several hours ahead of customary delivery time.

I fear to tread on the question of airplane size, except to mention that it must be remembered that larger airplanes permit higher ratios of useful load to gross weight and also greater range for a given load, as many airplane components and detail weights do not increase proportionately to the gross weight. Airplane size at present is limited by available engines, although this existing restriction may be reversed with the conception of large airplanes requiring several years to design and fabricate experimental prototypes. As a matter of fact, engines will need to be conceived and developed to permit lower fuel cost per ton mile and more miles per gallon or else air cargo expansion may find itself seriously curtailed especially for long range operation.

Cargo airplane size and capacity cannot be predicated until a thorough analysis of the air express and freight market has been made. All we know is that air express is here to stay and that its volume will depend on the cost of the service to the shipper. Also, that air freight will follow in the wake of any rate reduction which can be made to render its transportation competitive with other means.

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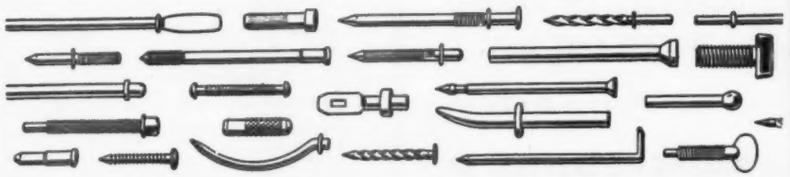

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cargo airplane must be as low as possible because on the basis of modern experience, depreciation amounts to, roughly, 10 percent of direct flight costs.

### Type Considerations

Generally speaking, the type of cargo airplane which appears most suitable points to a high wing bimotor with tricycle gear. For larger capacities and longer range, a four engine low wing might be considered superior.

Because of its simplicity, the bimotor type is more economical and meets the most important operating requirements for the following reasons:

1. It has the simplest powerplant combination and meets the requirement for safe operation and reliability with least servicing and maintenance. Single engine performance must be sufficient to maintain a safe altitude over the highest obstacle to be negotiated.

2. A high wing combination permits low fuselage and, therefore, low door height to ground, besides having ample wing to ground clearance to allow freedom of movement for ground vehicles without danger of hitting the wing.

Furthermore, large propellers may make a high wing or mid-wing location almost mandatory for any cargo airplane up to a given size.

3. The use of a tricycle landing gear is necessary to obtain a level loading floor and ease of loading and unloading.

In practically all landings, the pilot usually flares the airplane more than is necessary, with resultant higher vertical velocity upon impact on the runway unless lift is retained by high landing speed.

From an operational viewpoint, the elimination of the landing flareout necessary with the conventional type of landing gear is an advantage as with instrument landing in bad weather the airplane must be virtually flown to the ground.

One of the basic characteristics of cargo airplanes should be the largest possible center of gravity travel to eliminate critical load distribution.

### Cargo Compartment

The cross-section of the cargo compartment should be square or rectangular in section for maximum space utilization and cargo holddown anchor location simplification. There should be no sharp corners which might be a source of personnel hazard, besides being dirt collectors. The minimum height of the compartment should be 6 ft. 6 in. to allow walking throughout its entire length erectly.

There should be at least one large loading door on the left side, together with a smaller size one for crew entrance and exit at the front end of the same side. Preferably, and I repeat what I mentioned earlier, another large loading door should be located on the opposite side somewhat ahead of the left loading door to enable loading and unloading at the same time. The relative location of these doors lengthwise to the cargo compartment could readily be determined from actual experience with a mockup test.

The doors should be designed to present minimum obstruction to loading and unloading. Flush mounted sliding doors would best meet this requirement.

Cargo compartment floors should be on the same level to expedite loading and eliminate steps as a source of accidents. Such flooring should be of sufficient strength to take a high load concentration and the entrance door region should be designed to take a load concentration equal to the heaviest piece expected to be carried. This may require a good guess as about 90 per cent of all express packages are shipped in corrugated boxes or light wooden crates which can be carried by one man. However, the remaining 10 per cent may include aircraft engines weighing up to 3,500 or 4,000 lb. as well as other pieces of heavy machin-

(*Turn to page* 375)


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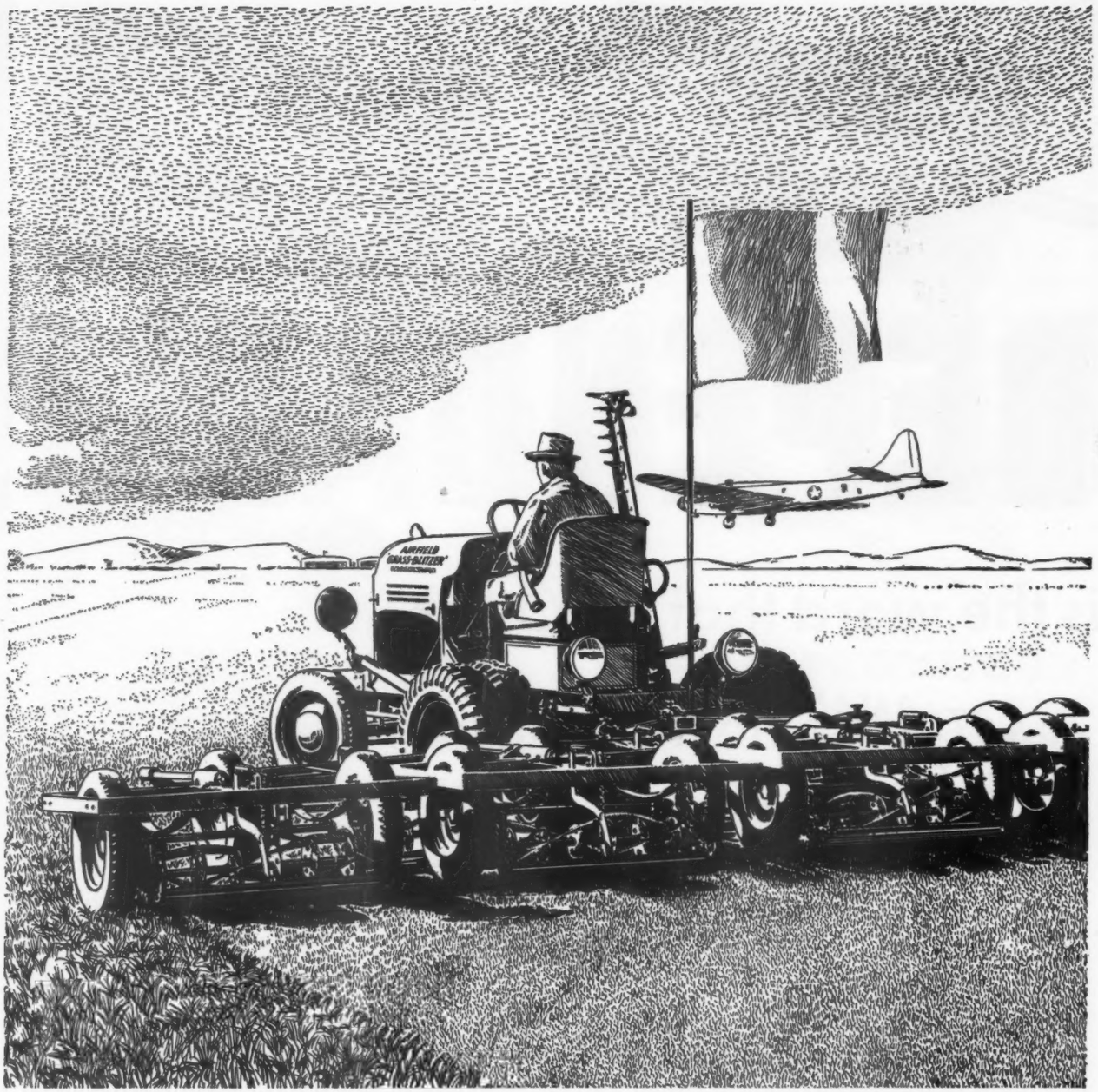


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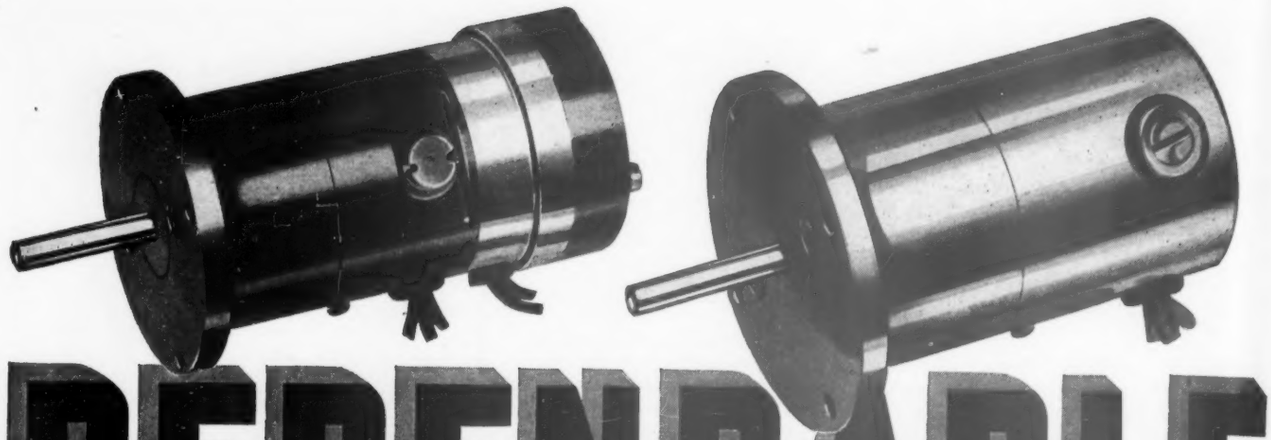

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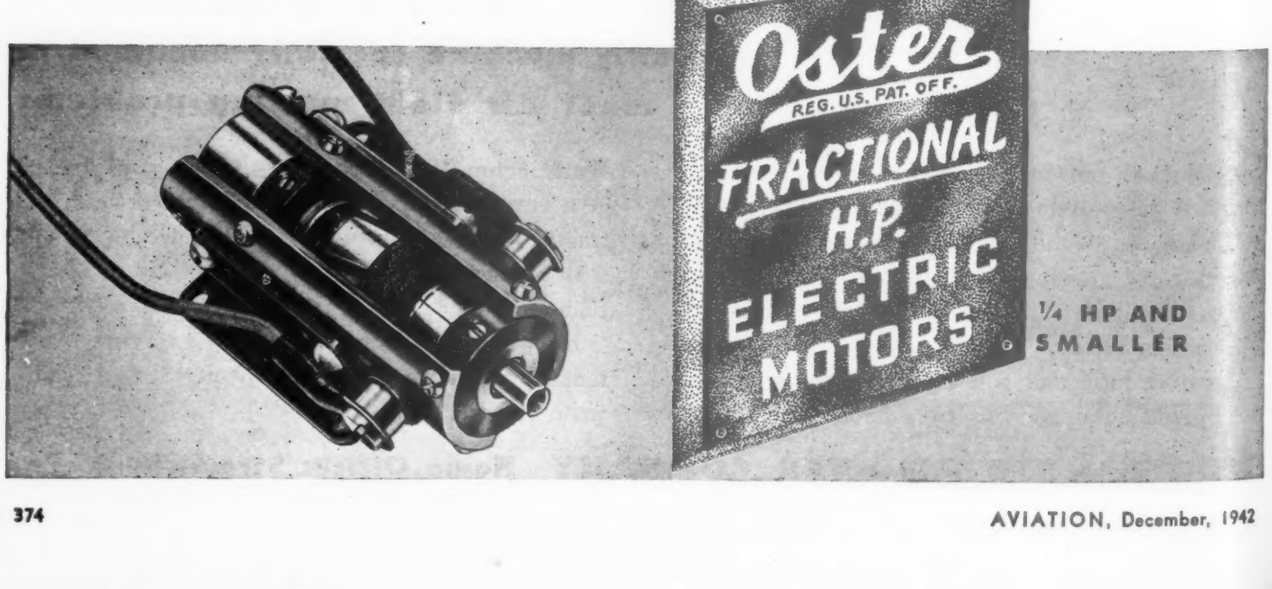


(*Continued from page* 372)

ery which have been carried in the past as emergency shipments.

From the economic point of view it does not appear logical to increase the empty weight of every cargo airplane of a fleet to handle this 10 per cent of cargo and the solution may be that only a few such cargo airplanes will be sufficiently strengthened to take what is virtually heavy freight.

Cargo space volume for any given airplane size should be based on an average express or freight density.

Rail freight averages 32 lb. per cu. ft. and rail express about 12 lb. per cu. ft., while airmail averages 9 lb. per cu. ft. If we assume that improvements in packaging can reduce express tare 20 per cent, we arrive at an air express density of approximately 9½ lb. per cu. ft.

Allowing for unusable space plus a certain amount of space in the region of the loading door which should probably be kept clear at all times, we can set down a density volume ratio of 8 to 9 lb. per cu. ft. as design criterion in determining the size of the cargo compartment.

Cargo stowage means should be light and efficient, suitable cargo tie-down devices should be provided flush-mounted and built integrally with the floor and side wall structures. Provisions should be made for a flexible segregation of the cargo compartment space into bins and sections, such as may be obtained by the use of movable stanchions with flexible partitions such as chain doors, which are light. The side walls up to a minimum height of 30 in. from the floor should be protected by means of suitable removable panels, fabricated perhaps from laminated plastic having varying thickness from the ground to their maximum height to secure least weight for maximum protection.

Only sufficient windows should be incorporated to give satisfactory light and these could be portholes. Cargo compartment lighting must be protected against damage. Such lighting should be adequate as much work will be done at night.

### Heating and Ventilation

The entire cargo compartment should be well-ventilated without being drafty. Heating should be provided in the design to maintain a 50 deg. F. temperature which is necessary when perishables such as flowers, fruits and animals are to be transported.

It will be necessary when operating in cold climates to provide temperature insulation and such insulation should be made readily removable for two reasons. First, weight saving when it is not needed, and second, to allow periodic cleaning.

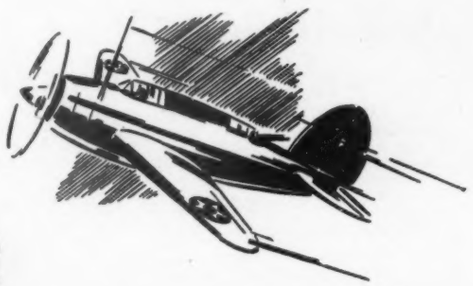
It is not believed that the cargo compartment, as a whole, needs to be soundproofed, although such soundproofing should be made available in sections in case it should be required.

Provisions should be made for air-conditioning and possibly refrigerating.

### Cockpit

Cockpit arrangement should include space for cargo handler station. The cargo handler's duties would be to keep track of all cargo pieces, check and prepare cargo manifest, check destination of cargo, supervise loading and unloading, check the CG location of the cargo for balance, as well as any other "in flight" duties which may be required.

A small cargo compartment should be provided and readily accessible from the cockpit for the safekeeping of valuables. This compartment should be close to the cargo handler's station as

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it would be his responsibility to care for such valuables.

### Miscellaneous

Among the miscellaneous operating requirements can be cited adequate fire protection for both power plant and cargo. For the latter, it is believed that a smoke detector should be a prerequisite as well as quick action extinguishing means.

Refueling and reoiling should be accomplished from the under-wing surface to eliminate the necessity of climbing over the top of the wing which in the past has always caused substantial distortion of the wing leading edge, has been the source of accident hazard, besides incurring additional labor time.

Obviously, powerplant assemblies must be designed so as to be quickly changed. This is a most desirable feature which has been lacking on all transport airplanes designed to date.

In general, reliability must govern detail design which should consider adequate bearing surfaces, ease of lubrication and self-lubrication for inaccessible places, adequate brakes, readily accessible and removable engine cowling and inspection doors bearing in mind that maximum utilization of equipment is one of the requirements for low operating cost.

In other words, the airplane should be designed so preventive maintenance and service methods can be best applied.

Cabin pressurization offers an increase in speed at high altitude but it is questionable as to whether the increase in structural weight and initial cost, as well as additional service and maintenance costs, will warrant its application to cargo airplanes, at least for the time being.

In order to simplify the ground handling of the cargo prior to loading or unloading, and gain a saving of ground time and labor, I would like to enter a plea for standardization of cargo loading door to ground height, possibly door size, cargo tie-down equipment within the cabin itself, and containers for the collective handling of small shipments, as it is not believed possible to standardize to any great extent on package size, except perhaps on the type and materials used in packaging in order to reduce tare which represents a high percentage of the total weight of the article being shipped. This is an important item which needs emphasis and will require an intelligent and imaginative study when it is considered that at present approximately 30 per cent of the weight of express shipments is packaging.

The development of air cargo will serve to accelerate the distribution of national and international wealth and promote similar commerce. It will allow greater enjoyment of the material wealth of the earth and it is hoped will also serve to eliminate intercontinental friction which since the world began has been the source of destructive warfare. This may be an idealistic goal, but it is my belief that the airplane, as a vehicle of speedy transport, can make it real.

## Safety Tips

A recent CAB report shows that more than 33 percent of civil non-air carrier flying accidents occur during landing operations. Safety hints:

1. Know the traffic rules of your own or any other airport where you may land.
2. Be positive of wind direction and velocity.
3. Satisfy yourself there is no danger of collision with other aircraft.
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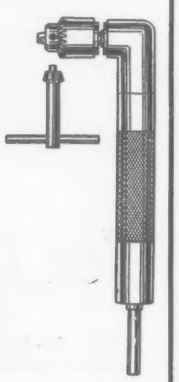

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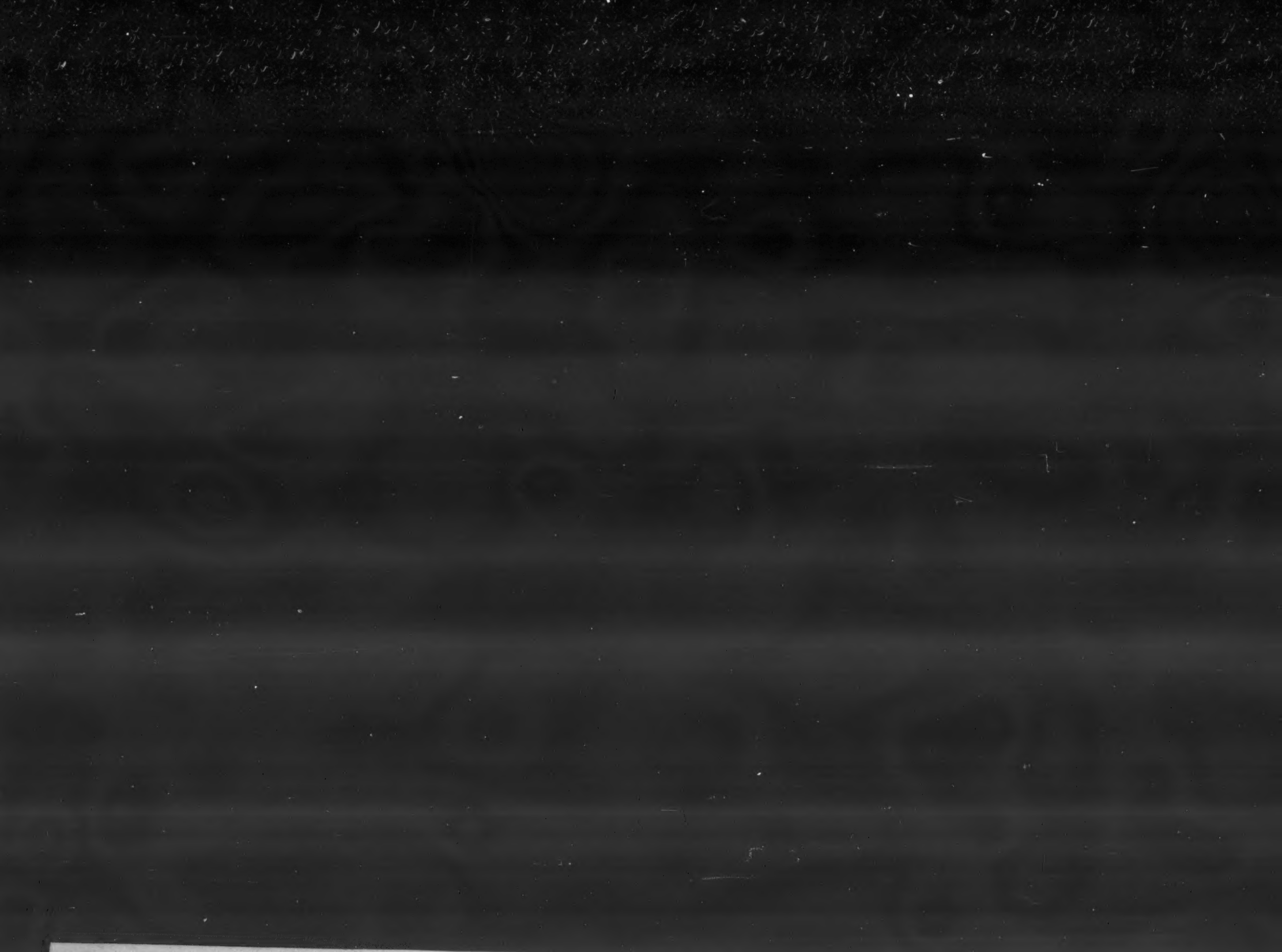
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